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NEW YORK UNDERGROUND RAPID TRANSIT RAILway affairs have made satisfactory progress during the week which has passed since the contract was awarded for its construction. According to the terms of the contract, the successful bidder must furnish one bond amounting to $1,000,000, to continue during 50 years; another of $5,000,000, to insure the satisfactory performance of the construction, and must make a deposit of $1,000,000 in cash. The time allowed for qualifying by furnishing these bonds is ten days from Jan. 16, which time may be extended ten days longer, if necessary. Failure to qualify will cause the forfeiture of the bidder's certified check of $150,000. The work must be finished in 4½ years. Briefly summarized, it comprises the following items:

Length of all sections, ft.	109.570
Total excavation of earth, cu. yds.	1,700,228
Earth to be filled back, cu. yds.	773,093
Rock excavated, cu. yds.	921,128
Rock tunneled, cu. yds.	368,606
Steel used in structures, tons	65,044
Cast iron used, tons	7,901
Concrete, cu. yds.	489,122
Brick, cu. yds.	18,519
Waterproofing, sq. yds.	775,795
Vault lights, sq. yds.	6,640
Local stations	43
Express stations	5
Station elevators	10
Track, total, lin. ft.	305,380
" underground, lin. ft.	245,514
" elevated, lin. ft.	59,766

The contractor, John B. McDonald, whose bid of $35,000,000 was accepted by the Rapid Transit Commission on Jan. 16, as stated in our last issue, announces that work will be begun soon after the contract has been signed, and that excavation will be carried on at numerous points along the line at the same time. The intention is to sublet a large portion of the work, and it is stated that contracts as small as for a single block of the tunnel will be sublet. The Rapid Transit Commission has taken under consideration the extension of the line to the Battery and thence to South Brooklyn. It also has a bill before the New York Legislature to amend the original rapid transit act so that the City Comptroller may issue the bonds for construction without the consent or concurrence of the Municipal Assembly of New York city.

THE ENGINEERING STAFF OF THE RAPID Transit Commission of New York is not yet organized, and will not be for some weeks. And for the benefit of engineers and others applying for places thereon, Chief Engineer W. B. Parsons, M. Am. Soc. C. E., has issued a notice stating that these positions will only be filled after examination of the applicant by the New York Civil Service Commission.

THE NEW YORK AND NEW JERSEY BRIDGE CO. is asking from the Sinking Fund Commission its approval of a "bridge approach" which would extend along the North River water front from W. 60th St. to the Battery. For this the bridge company offers the city the whole property at the end of 100 years; or, the option to purchase at any time by paying the value of the property; it declines to entertain any proposition to pay to the city a percentage of gross receipts. As viewed by Comptroller Coler, and by the Mayor, the company's proposal amounts to asking for the free grant of a privilege that for 100 years would absolutely control the handling of all the traffic coming by steamship to this port; and for this lucrative privilege the city would get nothing for a century.

ALL THE STREET RAILWAYS OF WASHINGTON, D. C., are required by act of Congress to sell six tickets for 25 cts., and the tickets issued by any one line are good on any other within the District of Columbia. This information is supplied by a resident of Washington, as a correction to the statements regarding that city published under the title, "Street Railway Franchises in American Cities," in our issue of Jan. 4, 1900.

A NICARAGUA CANAL BILL IS LIKELY to pass Congress at the present session, according to a canvass made by the "New York Herald." A majority of both the House and the Senate are reported to favor its passage, and Speaker Henderson and Senator Frye, President pro tem of the Senate, are conceded to favor action at the present session. The House bill authorizes the President to acquire from Costa Rica and Nicaragua control of such portions of their territory.

as may be desirable and necessary on which to excavate, construct and defend a canal of such depth and capacity as will be sufficient for the movement of ships of the greatest tonnage and draft now in use, from a point near Greytown, on the Caribbean Sea, via Lake Nicaragua, to Brito, on the Pacific Ocean, and such sums as may be necessary to secure such control are hereby appropriated out of any money in the Treasury not otherwise appropriated.

When such control is acquired, the Secretary of War is to proceed with the construction of the canal, which is to be large enough to accommodate "vessels of the largest tonnage and greatest depths now in use." The sum of $140,000,000 is appropriated for the work of construction.

THE SOUTHWEST PASS IMPROVEMENT, at the mouth of the Mississippi River, has been reported upon by the board of engineers appointed to study the problem. This board included Col. H. M. Roberts and Major G. McC. Derby, Engineer Corps, U. S. A., and Major William Starling and Mr. Robert Moore, Mems. Am. Soc. C. E., and civilian engineers. To create a 38-ft. channel this board cuts down the cost from the original estimate of $13,000,000 to $6,000,000. This is done, says the "Times-Democrat," by substituting for the heavy riprap and masonry work used in the South Pass jetties, a lighter construction. The board recommends that the jetties be built of concrete, in a wall 9 ft. wide on top, with steep slopes, resting upon rock-ballasted willow mattresses 150 to 200 ft. wide at the base. The channel marked out would be 7,000 ft. wide as a maximum and 3,000 ft. as a minimum for the upper end; while the lower end of the channel will be between parallels 2,850 ft. wide in the clear. The maximum weight of 300 lbs to the sq. ft. is assumed for the walls; and these walls will rest immediately upon 12 × 12-in. creosoted white pine grillage, supported by the mats, thus distributing the weight of the concrete over a greater area. This grillage will spread and increase in height as the water deepens; though no mention is made by our contemporary as to the estimated duration of this timber work—even though creosoted. The board assumes five years as necessary to complete the work. The whole purpose of the new plan is to provide a construction that will not sink so deeply into the soft deposit as did the old works at the South Pass. The ultimate settlement is figured at 5 ft. in this case.

THE INTERNATIONAL CONGRESS OF NAVIGATION is to hold its next session in Paris, commencing July 28, 1900, and a bill is now before the U. S. Senate authorizing the President of the United States to invite this congress to hold its 9th session in Washington, D. C., and appropriating the sum of $25,000 to be expended for this purpose under the direction of the President. As this invitation must be presented to the Paris meeting next July, there is evidently no time to lose in acting upon the bill. In view of the important nature of the matters discussed by these congresses, and the wide engineering and commercial interests involved in the waterways of our own country, it is to be earnestly hoped that this bill will pass, and the 1901 meeting be held in Washington. It would mean bringing to the United States the leading experts in the world on matters connected with navigation, and a discussion of our own many projects of that nature, with all the benefits accruing from such discussions.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred in the Oxford tunnel, near Belvidere, N. J., on the Delaware, Lackawanna & Western R. R., on Jan. 17. A freight engine ran into a party of track laborers, killing three and injuring six men.

A TUBE IN THE BOILER of the government launch "Caperon," lying in the canal locks at Delaware City, exploded on Jan. 17, scalding nine men, three of them so seriously that they may die.

THE FOREIGN COMMERCE OF THE UNITED States in 1899, says the U. S. Bureau of Statistics, amounted to $1,275,486,641 exports, and $799,834,620 in imports; an excess of exports over imports of $475,652,021. Of the exports more than 30% represented manufactured goods, as against 26% in 1897, 23% in 1895, 20% in 1885 and 12% in 1860. Of the imports 33% represented articles in a crude condition and used in our domestic industries. Products of agriculture formed 63% of the exports, against 70% in 1898, and 83% in 1880.

AMERICAN RAILS FOR BORNEO is one of the latest indications of the extending field of the export trade in American iron and steel manufactures. These rails will be used on the British North Borneo Ry., and the order, which is being filled by the Carnegie Steel Co., comprises several thousand tons. The rails will be inspected at the mills for the railway company by Mr. F. Stuart Williamson, M. Am. Soc. C. E., of New York, N. Y.

THE AMERICAN EXPORT BUSINESS is badly handicapped, says Mr. R. A. Blackwell, of Blackwell & Co., of London, by the careless manner of filling orders and still more careless methods of packing for shipment. Mr. Blackwell is an American extensively engaged in the importation of American electrical equipment. He says that while the field in England is unlimited for American manufactured goods, to occupy it Americans must learn something of the rigid inspection to be passed and of the foreign methods of shipment. He referred to the late rejection of 300 tons of 4-in. pipe, because two-thirds of the pipe delivered was 3⅝ in., and the rest 3 to 3⅝ in.; 3,000 trolley poles were likewise thrown out because of bad casting; and 40 trolley cars were rejected on account of bad workmanship, and 10,000 ft. of American trolley wire would not stand the tension test.

THREE-PHASE ALTERNATING CURRENTS, generated by water power, are used by an electric railway 20 miles in length running between Burgdorf and Thun, Switzerland. The power station is located at Spiez on the Kander River and contains four groups of turbine generators of 6,300 HP. capacity. The turbines operate under a head of 200 ft. The current is generated at 4,000 volts and is raised to 16,000 volts for transmission. Fourteen transformer substations are situated at equal intervals along the road. The transformers are of 400 K.W. capacity each and deliver three-phase currents at 750 volts. Two trolley wires are provided, the track, which is bonded, acting as the third conductor. Motor cars are used for passenger service and electric locomotives for freight. Each locomotive is equipped with two 150 HP. motors running at 300 revolutions per minute. The rotors of the two motors are keyed to a single shaft which may be connected to the axles by either of two trains of gearing for two different speeds. The locomotive carries a static transformer which reduces part of the current to 100 volts to be used in lighting the car and operating a 3 HP. motor-driven compressor supplying air for the air brakes. The motor cars are of the double truck type and are equipped with four 50-HP. motors, one to each axle. Two sliding contact bows at each end of the car serve as trolley poles. A constant speed of 22 miles per hour is maintained.

THE VALUE OF NEW ENGLAND WATER-POWER is discussed by the Providence "Journal," and the following table is given showing the rates charged per theoretical horse-power, for permanent and surplus supply. By permanent power is meant a guaranteed amount for each day in the year, and the surplus is an excess over this amount which may be used in the higher stages of the stream:

Company.	Perm'nt Water annual paym't per gross H.P.	Surplus Water annual paym't per gross H.P.
Ansonia Land & Water Power Co.	$20 00	$8 33 to $16 67
Ousatonic Water Power Co	20 00	8 00 to 12 00
Union Water Power Co. (Farmington River)	11 35	
Bellows Falls	7 50	
Turners Falls	7 50	
Holyoke Water Power Co.		8 87 to 17 74
Connecticut River Co.	17 70	
Union Water Power Co. (at Lewiston)	1 83 to $9 37	
Manchester	3 47	7 75
Lowell	3 53	3 67 to 72 50
Lawrence	3 53 to 14 08	14 38 to 28 76

In the recent development of the water resources of the Blackstone River, by the building of reservoirs, the commissioners report an average cost per horse-power of $16 per year, at 4%; or $20 per year at 5%. The average cost per horse-power paid to the above companies is about $10 per year. On the basis of 2 lbs. of coal, at $3.00 per ton, required per horse-power hour, steam power will cost $20 or over per yearly horse-power.

THE ZANESVILLE, O., TIMBER HOWE TRUSS Y-BRIDGE BUILT IN 1831-2.

One of the most interesting examples of wooden bridge construction, which is standing at the present time in the United States, is the old double roadway Howe truss Y-bridge crossing the Muskingum and Licking rivers, at their junction in the city of Zanesville, O. This bridge was begun in 1831, and completed during the following year, and has, therefore, withstood the ravages of time and the elements for 68 years. During all these years the bridge has been in use continuously, and until

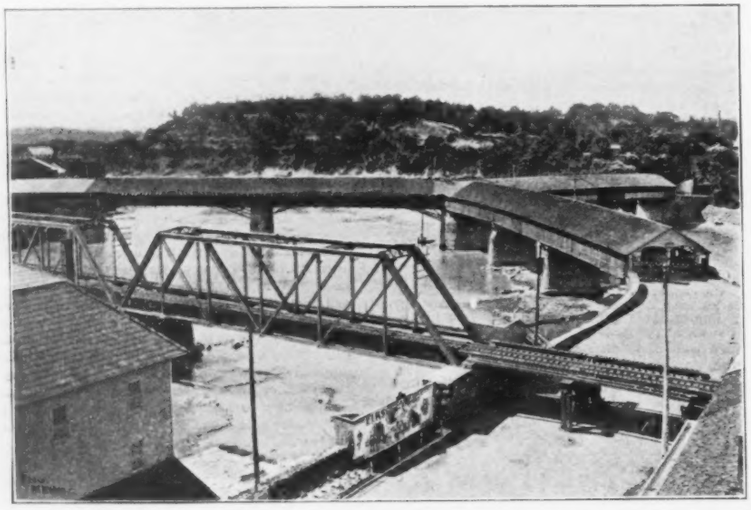

FIG. 1.—VIEW OF WOODEN HOWE TRUSS Y-BRIDGE BUILT IN 1831 AT ZANESVILLE, O.

within the last ten it has required only a few repairs, and these were of an unimportant character. The hard service of three-score years had made itself felt, however, and for the last few years the old structure has been giving away, at first one place and then another, and has had to be tinkered up and braced together in various ways to keep it in service. Finally, to the constantly growing roadway traffic there was added an electric railway line, and the overstrained and aged timbers have split and broken under their heavy load until it was no longer possible to repair and renew them, and the bridge has been condemned as unsafe and no longer able to continue the work which it has performed so well for nearly 70 years.

The building of the Zanesville "Y-bridge," as it is locally designated, was a considerable undertaking at the time it was started, and that it has endured so long speaks remarkably well for those who designed and erected it. As will be seen from the illustrations, it is a covered double roadway bridge carried on masonry piers. When built the superstructure consisted of three parallel wooden Howe trusses, the inclined under bracing against the piers being a later construction for the purpose of strengthening the trusses. In plan the bridge is Y-shaped, as shown by Fig. 2. Fig. 1, which is a general view of the bridge, shows very clearly its external appearance, which has remained practically unchanged since 1832. In the foreground of this view is shown the Baltimore & Ohio R. R. bridge, a modern pin-connected steel structure, and a great contrast to its ancient neighbor. From the report of the Osborn Co., of Cleveland, O., who have recently examined the old bridge in detail to determine its safety and fitness for further use, we take the following extracts relating to its general construction:

Substructure.—The substructure consists of three abutments, five piers, and one large center pier. All these structures are built mostly of a good quality of limestone, obtained a few miles up the river. Most of the stone work in the piers is cut with some care in regular courses, and the joints are well fitted. In the abutments random masonry has been used to some extent. All of the piers and abutments are built of cut stone for facing, and the facing stone appears to be about 2 ft. thick. The interiors of all these structures do not appear to be laid up in any class of masonry, with the exception possibly of the up-stream noses or starlings, where the force of current is considerable, and where more carefully laid blocks of stone exist. These interiors appear to have been left hollow, and filled afterwards with small stone and riprap. There are many places in all of the different structures where a wire can be entered from two to three ft., showing that the joints are open throughout, and that the filling inside is by no means solid, and contains no mortar.

Even the large pier standing at the junction of the three arms of the bridge consists of a shell of masonry about 2 ft. thick, the interior being filled partially with stone filling and the rest entirely hollow. It would hardly seem to have been the best form of masonry construction to support the combined weight of three spans in the way that it does. Still the masonry is in general not in so bad condition as might be expected. The up-stream or curved face has, however, badly deteriorated.

Superstructure.—The general design of the bridge is what is known as a wooden Howe truss and is an excellent example of the best practice in wooden bridge building of the times in which it was built. At the time there was very little known about stresses, etc., and such work was designed largely by what had been done before and what in the judgment of the builder would be best suited for the purpose. A careful examination of the timber shows that it was very carefully selected and was exceptionally good. The poplar in particular shows great care in selecting only clear, sound timber, and to this fact, and that the whole structure was covered and the members of the trusses thereby protected from the weather, is in great measure due the exceptionally long life of this remarkable structure.

The report gives the dimensions of some of the principal members of the 150-ft. and 115-ft. spans, which we have summarized in the following tabular form for convenience:

	Dimensions in inches.	Sectional area, sq. inches.
150 ft. spans: Top chord.....	two, 8 × 10	160
Bottom chord.....	two, 6½ × 12	156*
Main end diagonal.....	one, 9⅝ × 9¼	95
115 ft. spans: Top chord.....	two, 8 × 8	128
Bottom chord.....	two, 6½ × 12	156*
Main end diagonal.....	one, 7⅛ × 9½	71

*Bolt holes reduce the net section to 120 sq. ins.

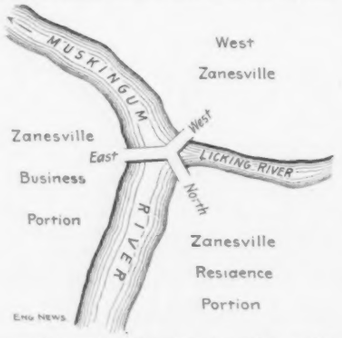

Fig. 2.—Sketch Map Showing Location and General Plan of Old Wooden Y-Bridge, at Zanesville, O.

The report states that all of these members are very greatly overloaded, and says:

We made borings of nearly all of the diagonal members in the north trusses of the 150-ft. spans and found that in every case dry rot commenced in the centers and had destroyed about 2 ins. of the core, leaving the section greatly weakened. With the rot started in these members and the large open cracks extending in many cases into the center, supplying moisture it will be a matter of but a very short time before the whole section is practically destroyed. The oak seems to be in very good condition, but several instances were noted where large knots destroyed a large percentage of the section. If the oak was used for compression members the knots would not affect the strength to any great extent, but in all cases the oak is used for tension members and therefore every knot or trasverse crack destroys that much efficient section.

What has undoubtedly contributed to the preservation of this bridge more than anything else is the fact that it has been covered with a water-tight roof and therefore not exposed to the action of the elements. This roof is now rotten and full of holes and has changed entirely from a protection to a menace. The roof leaks and allows water to trickle down into the checks and cracks of the timbers, and accelerates the deterioration many fold. We have stated that the oak timber was in good condition. This cannot be said for the poplar as, aside from the dry rot which has started in the inside, the sound wood itself has become so old that it seems to have lost nearly all its elasticity or what is usually known as "life."

In concluding their report the engineers of the Osborn Co. condemn the bridge as unsafe and dangerous to use, and state that nothing less than a practically complete rebuilding will place it in good condition. We are indebted to Mr. R. G. Collins, Jr., Civil Engineer and Surveyor, of Zanesville, O., for the information from which this description has been prepared.

THE FORT DODGE & OMAHA R. R. (ILLINOIS CENTRAL R. R. SYSTEM.)

(With full-page plate.)

Within a short time there will be a new route between Chicago and Omaha, as the Illinois Central R. R. is completing a line from Fort Dodge, on the Sioux City Division, to Council Bluffs, where connection will be made with the railway bridge over the Missouri River to Omaha. As the charter of the Illinois Central R. R. did not give it the right to build railways in Iowa, a charter was obtained in that State for the Fort Dodge & Omaha R. R., under which the road is being constructed. When completed, however, the road will be absorbed by the parent company and become a part of the Illinois Central R. R. system. The map, Fig. 1, shows the general route of the line.

The line passes through a rich farming country, which will eventually provide a good local traffic, but the main object of the line is to obtain a portion of the through traffic, for which purpose a fast train service will be established. Leaving the Sioux City line at Tara, 6 miles west of Fort Dodge, the line strikes across a rolling prairie to Wall Lake, where is the divide between the watersheds of the Missouri and the Mississippi rivers, the lake itself having an outlet to both rivers. Beyond this, the line follows the valley of the Boyer river until it reaches the valley of the Missouri, when it strikes boldly across the flat bottom land, while the older line of the C. & N. W. Ry. follows around the foot of the bluff.

The length of the new line from Tara to Council Bluffs is 130.8 miles, and the total distance from Chicago to Omaha will be 512 miles, or only about 10 miles longer than the existing lines, so that the fast trains over the new route will be in direct competition with those of other lines. The line will not be a difficult one for such trains. Between Tara and Council Bluffs there is but one curve of 3°. Between Tara and Wall Lake, 45 miles, the maximum grade is 26 ft. per mile (or 0.5%); while between Wall Lake and Council Bluffs the maximum is only 16 ft. per mile (or 0.33%). The longest tangent is 31 miles, extending from the west end of the yard at Tara. On this new line, the tangents aggregate 90.14%, and the curves 9.86% of the length. The total amount of curvature is as follows:

Amount under 3°.....	85 degs. 02 mins.
Amount under 3° and over 2°...	39 degs. 10 mins.
Amount 2° or under.....	773 degs. 44 mins.
Total	897 degs. 56 mins.

The accompanying profile, Fig. 2, shows the principal elevations. At Tara, the elevation is 1,152 ft. above sea level; Rockwell City, 1,223 ft., and the highest elevation is at the crossing of the C. & N. W. Ry., just west of Ulmer, 1,273 ft. From this point the line has a general fall westward, the elevation at the Council Bluffs station being 987 ft. This profile is taken from one of the blue print progress profiles, which have three broad white lines along the base; one for grading, the other for rail laying, and the third for ballasting, the monthly progress being marked on these lines.

The new line has been built very rapidly, under the direct supervision of Mr. John F. Wallace, M. Am. Soc. C. E., Assistant Second Vice-President, this step being taken on account of the great amount of work already devolving upon the Chief Engineer, Mr. D. Sloan, M. Am. Soc. C. E., and the desire to push the work to completion as rapidly as possible. Work was commenced in May, 1899, but was delayed by bad weather, so that not till July could the work be vigorously prosecuted. At one time about 1,000 to 1,200 men were employed, and on the occasion of a trip recently made over the road by a member of the editorial staff of this paper, over 20 ballast trains were at work. When the line is open for traffic it will be added to the jurisdiction of Mr. C. K. Dixon, Superintendent of the Sioux City Division, who will then have charge of the two lines from Fort Dodge to Sioux City and to Omaha.

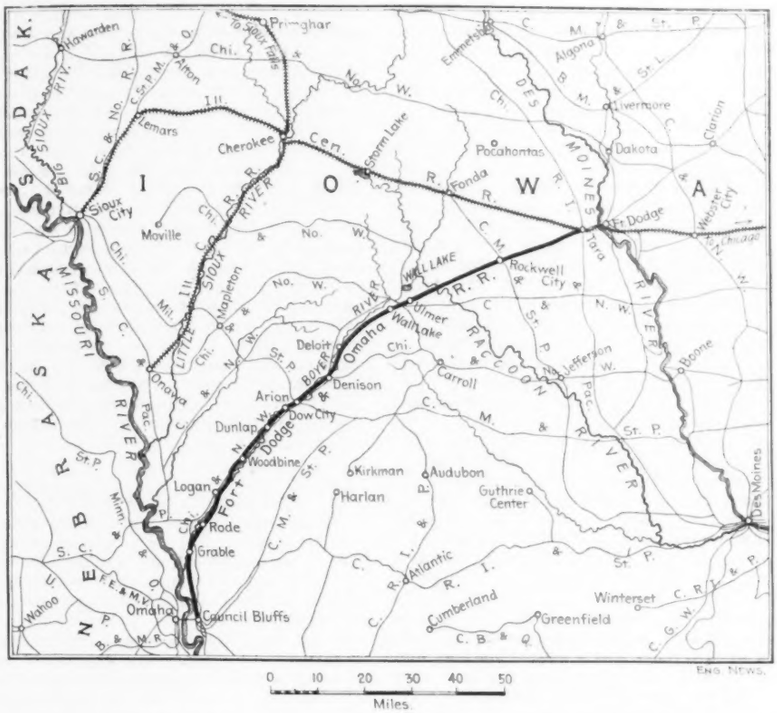

FIG. 1.—MAP OF FORT DODGE & OMAHA R. R.; (ILLINOIS CENTRAL R. R. SYSTEM).

Construction.—There were no great engineering difficulties encountered in the construction. The grading was done partly by drag and wheel scrapers, and partly by grading machines, while on one contract narrow gage dump cars and locomotives were employed. Where the haul was considerable, the scrapers were run onto a platform over a track and dumped the earth through a hole into a car standing below. In order to get a track open as soon as possible, track was laid through some of the cuts before they were excavated to the grade line, the track being kept at one side of the cut to allow room for the graders to work. Near the Missouri River, there are cuts through the bluffs of solid silt, the faces of the cuts being as smooth as though cut through cheese. This material is left at a very steep slope, so as to shed the water, as on a flat slope the water would soak in and make it liable to slide. The silt contains a considerable proportion of sand, and makes good material for banks, and even for ballast, being used for this purpose on some roads west of the Missouri River. If put up dry and well sloped it will go through a wet season in pretty fair shape, but of course it cannot be worked when wet. The flats or bottom lands between the bluffs and the river are liable to be flooded, but there is little current, and the banks and bridge openings are protected from wash by rip-rapping and brush mattress work.

The tracklaying was done by the railway company, and some material was sent to Council Bluffs by rail so that work might be carried on from both ends. The progress of this work was as follows: July and August, 48 miles; September, 25 miles; October, 58 miles. Communication throughout the whole length was opened on Nov. 1, 1899. While the road has been built rapidly, it has been built substantially, the idea being to have it fit to carry fast and heavy trains from the very first, and to do this without discomfort to the passengers. After the first winter season, all settlements will be filled in, banks widened and trimmed, and additional ballast laid for the entire line.

For construction purposes, the line was divided into four divisions, the contractors and engineers on which are given below; Mr. C. E. Grafton, M. Am. Soc. C. E., was Engineer in Charge of the whole line.

Division No. 1.—Length, 36.58 miles. Division Engineer, E. K. Blanchard; Resident Engineers, T. N. Jacob, J. E. Hildt, H. C. Allen and G. E. Boyd. The contract for grading was let to C. E. Loss, of Chicago, and included 443,378 cu. yds. of cut and 787,104 cu. yds. of fill. The culverts and trestles, amounting to 3,321 ft., were built by the railway company.

Division No. 2.—Length, 33.26 miles. Division Engineer, Wm. McCloy; Resident Engineers, S. T. Morse, L. W. Baldwin and O. W. Sullivan. Contractors for grading: McGee, Kahmann & Co., of Kansas City, Mo., 160,463 cu. yds. of cut and 543,989 cu. yds. of fill; J. D. Lynch, of Monmouth, Ill., 95,299 cu. yds. of cut and 404,565 cu. yds. of fill. Contractor for trestles, Geo. B. Swift Co., of Chicago, 1,970 lin. ft.

Division No. 3.—Length, 39.48 miles. Division Engineer, A. E. Harvey; Resident Engineers, H. J. Wright, F. W. Van Oven, W. P. Hoppin and S. W. McCauley. Contractors for grading: J. D. Lynch, 44,838 cu. yds. of cut and 548,529 cu. yds of fill; McGee, Kahmann & Co., 160,255 cu. yds. of cut and 685,506 cu. yds. of fill. Contractor for trestles, J. S. Patterson Co., of Chicago, 4,292 lin ft.

Division No. 4.—Length, 20.72 miles. Division Engineer, D. B. Scott; Resident Engineers, Lee Highley, H. L. Corthell and J. R. Doty. Contractors for grading: E. A. Wickham, of Council Bluffs, Ia., 42,002 cu. yds. of cut and 472,930 cu. yds. of fill; J. H. McShane & Co., of Omaha, Neb., 492,842 cu. yds. of fill. Contractors for trestles, Campbell & Saguin, of Council Bluffs, 6,638 lin. ft.

On the profile, the upper of the two horizontal rows of figures at the top represents the distance between stations, or between centers of passing tracks, while the lower row represents the distances between the outlying switches of stations and passing tracks. The distances between water tanks are also shown. The grades are marked on the profile line and the elevations on the vertical lines from the base to the profile, but only a few of these are marked on our cut. Below the base line are indicated the 22 track sections, and here a single circle indicates water stations, two concentric circles indicate section houses, and a cross indicates that the section headquarters are in the town.

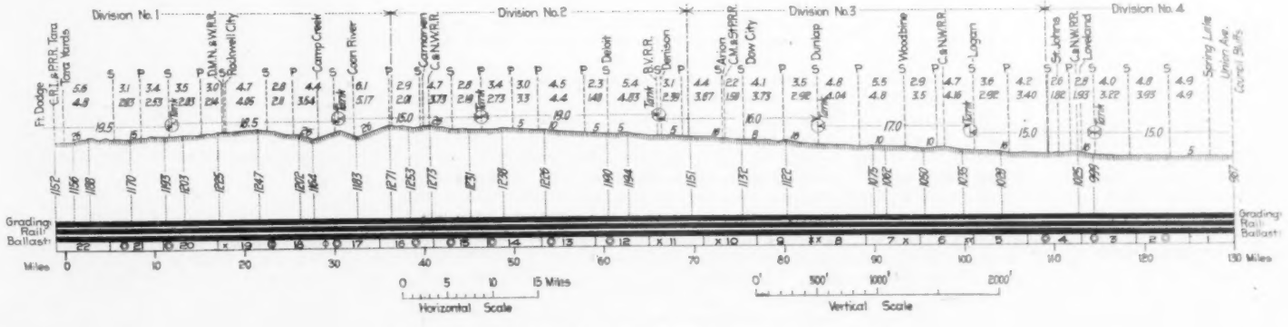

FIG. 2.—PROFILE OF FORT DODGE & OMAHA R. R.

Bridges.—There are a few trestles, all of which will eventually be replaced by bridges or by culverts with solid embankments. The longest trestle is about 2,000 ft. in length, in replacing which there will be three bridge spans over a road and two creeks. The abutments are all built for double-track superstructures, and are mainly of magnesian limestone, from Farley, Ia., but concrete is

riving at the same results, and the use of sheet metal shells formed in dies.

With a block having more than one sheave, center-pieces are used having interlocking lateral projections connecting them firmly with each other and with the cheek-pieces. In this case two upper shackles with square shanks are employed instead of one, so as to bring as much of the strain as is possible in line with the side-pieces. In all cases the shell is securely held together by the sheave-pin, or axle.

RAILWAY IMPROVEMENT WORK IN ILLINOIS.

At the annual meeting of the Illinois Society of Engineers and Surveyors, held at Moline, Ill., Jan. 24 to 26, considerable attention was given to the extensive works being undertaken in effecting permanent improvements on the railways. The matter was referred to in the report of the Committee on Railroads, and two papers on this subject were also presented. The report above mentioned called attention to the fact that one of the striking features of railway work within the past few years has been the amount of work done and the enormous amount of money expended in effecting permanent improvements. The most important items of this work were given as follows: (1) Reduction of grades and curves; (2) double tracking; (3) widening embankments and cuts and protecting their slopes; (4) establishing, enlarging and rearranging yards and terminals; (5) replacing trestles with solid embankments; (6) replacing trestles, wooden bridges and old iron bridges with new steel structures; (7) eliminating grade crossings; (8) constructing new stations of a better class; (9) improving the water supply and water stations; (10) extending the use of the block system, signaling and interlocking. Work of this character is undertaken largely for purposes of economy, in order to increase the traffic capacity of the line and to reduce the charges for maintenance and operation. The report showed that on the Illinois Central R. R., for instance, practically all these kinds of improvements are now being carried out.

We give below abstracts of the two papers which were presented at the meeting, and which dealt with the improvement works carried out on two individual lines during the year 1899. It is of interest to note that concrete was extensively used on both these roads.

Improvement Work on the Chicago, Burlington & Quincy R. R.

E. P. Chapin.*

The improvement on the main line of the C., B. & Q. R. R., in Illinois, during the summer of 1899, consisted in reducing the ruling eastbound grades from 0.7% to 0.4%; changing the alinement at points where curves of more than 2° per station existed (making the maximum on new work 1° 30'), and replacing the single track bridges over the main and west branches of Bureau Creek with new double track structures; one of these is 403 ft. long and 82 ft. high, and the other is 323 ft. long and 68 ft. high. At Princeton the change in grade extended over a distance of 16,700 ft., the east 7,000 ft. of which was excavation, the maximum depression being 13 ft. below top of tie in an existing cut of 6 ft. At each end of the work double crossovers were placed, with telegraph stations and semaphores, so that either main track could be used for traffic without disturbing work trains.

The construction equipment consisted of a Bucyrus steam shovel of 2 cu. yds. capacity and three trains of 10 flat cars, each train having its own engine and crew. As the material handled was a wet, heavy clay, and unloaded by side plow, it was necessary to have a fourth engine to help on the cable in unloading. The first cut was made north of the main tracks, the shovel cutting to grade until a depth of 7 ft. below top of tie was reached, that being the extreme depth from which it could dump into cars standing on the main track. The north main track was laid through this cut immediately on its completion, and the shovel started through the second cut, taking it to grade all the way. The third cut completed the work, the south main track being temporarily in the second cut. Thus two through connected tracks were kept in operation at all times; and the delays to traffic were only those due to operating a single track during working hours. The amount of earth removed was 121,137 cu. yds. in car loads averaging 6.52 yds. each. Two of the three highway grade crossings east of town were carried over the main tracks on small trusses having a clearance of 22 ft. above the rail. The maximum raise was 12 ft. on a 33-ft. embankment, the cross-section quantities of fill being 98,000 yds. A 20-ft. arch culvert of cut stone was extended 20 ft. on each end with Portland cement concrete, mixed in proportions of 1 part cement, 3 parts sand and 6 parts stone in abutments and wing walls. The arch was constructed of six rings of No. 1 vitrified paving brick laid in Portland cement mortar.

At Buda and Galva the same arrangements were made for using one track for construction purposes, alternating the traffic from one to the other as the work required. At both of these places the embankment was largely in excess of excavation, so that the loading was done mostly from borrow pits with work trains standing on temporary sidings.

The Walsh Construction Co., of Davenport, Ia., secured the contract for both jobs, and began work at Buda on May 24. The change here covered 12,000 ft., the east 2,000 of which was depression, the existing 23-ft. cut being deepened 6.5 ft., and the earth removed amounting to 28,000 yds. The west 10,000 ft. was elevated, the greatest raise being 18 ft. on an existing 13-ft. embankment. The quantity of earth placed in the bank was 324,000 cu. yds, and the average haul from borrow pit was two miles. The contractors used a Bucyrus shovel with dipper of 1¾-yd. capacity and two switch engines, each handling a train of 16 standard gage, 5-yd., side-dump cars, made by the Western Wheeled Scraper Co., of Aurora, Ill. The work was prosecuted night and day, in two shifts of ten hours each. A comparison of the serviceability of flat cars and cable with the side-dump cars is greatly in favor of the latter. Under very favorable circumstances a train of 16 loaded cars has been dumped and righted, ready to return to the shovel, in two minutes; and the average actual working time was about six minutes, or one-third the average of flat cars and plow. The train load was 65 yds. in each case. The work was completed Aug. 29, having covered 98 days. The only highway grade crossing on the elevated stretch was changed to an under crossing. The pumping station at Coal Creek, about the middle of the fill, was moved 60 ft., a new intake well constructed, and about 1,700 ft. of 8-in. supply pipe was moved 15 ft. laterally, and lowered 6 ft., without shutting off the water supply.

The work at Galva was very similar to that at Buda, the total length of change being 12,900 ft. The west 3,900 ft. of track was depressed, 9 ft. being the greatest depth in a cut ranging from 7 to 15 ft. deep. The cross-section quantities were 39,000 yds.; but as the borrow pit adjoined the right of way at this point, the total amount of earth required was obtained by working the shovel back from the track in parallel cuttings. The elevation extended over 9,000 ft., the greatest raise being 17 ft. on a fill of 19 ft., and the total amount of earth placed in embankment was 185,000 yds. Work was commenced July 28, with the same force as at Buda. On Sept. 1 the force was increased by the addition of the Buda shovel and one engine and train of 16 cars. With this force, two steam shovels and three trains of side-dump cars working 20 hours, the best day's record was 3,700 yds. moved, the average haul being one mile. The work was finished Nov. 9. The only grade highway crossing was carried overhead, with a clearance of 32 ft. above the rail. During the work at Princeton, Buda and Galva, the average number of trains per day passing over the tracks was 58, exclusive of work trains.

Between Kirkwood and the Mississippi River, a stretch of 20 miles, the changes in alinement abandon 8½ miles of old roadbed and eliminate 344° of curvature. The new location crosses the old ten times, and always on a different grade. The general direction, however, of the old line was so near the proper bearing that less than ¼ mile in distance is saved. All bridges on the new line are deck girders on concrete piers and abutments. One 12-ft. arch is constructed entirely of concrete. Smaller culverts on the new line are of iron pipe without foundations or end walls, the pipe being long enough to project through the slopes. There were, however, on this line and on the works previously mentioned a number of stone box culverts which were lengthened with concrete. The side walls were brought up to the proper height and covered with pieces of old rail laid 12 ins. apart, c. to c., and having not less than 18 ins. bearing on side walls. The form for the cover was then made by laying planks under the rails, flush with the top of walls and covering with 12 to 18 ins. of concrete, being careful to fill in the space between the rails. The reasons for using concrete for all masonry structures were as follows: (1) cheapness, the cost being only about 70% of cut stone; (2) the fact that the material could be obtained on very short notice; (3) that steam power was not required except in pumping out foundation pits, and (4) that an intelligent foreman can soon train a gang of laborers so that they will be expert in concrete work.

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Improvement Work on the Illinois Central R. R.

W. E. Angier.*

This paper is not intended to cover works of maintenance of present structures or track, but to include such work as has been done during the year 1899 in the line of permanent improvements, which have tended to raise the standard and increase the efficiency of the road.

Work on the second track from Otto to Gilman, 21 miles, was begun in the latter part of 1898, but it was completed and put in service in 1899. This gives a double track from Chicago to Gilman, where the St. Louis trains diverge from the main line south. This track was laid with 85-lb. steel rails and stone ballast. It required the changing of one single track 96 ft. through span for a double track span of same length; the building of one through plate girder bridge of 47 ft. 6 ins span, and two 34-ft. deck plate girder bridges.

The Illinois Central R. R. has now two engines, each weighing approximately 164 tons, including tender. It is estimated to use these engines on that part of the road between Carbondale, Ill., and Fulton, Ky., where the heaviest grades are found between Chicago and St. Louis and New Orleans; and it is desired to have engines that will haul as large loads over this part of the road as the present lighter engines will haul north and south of it on the easier grades. In order to permit of the use of these engines it has been necessary to replace part of the bridges which were considered too light for such traffic. This work is now being done, and includes the following: (1) One single track bridge of 123-ft. span replaced with a bridge having one truss strong enough to act as the center truss of a double track bridge; (2) one single track bridge with a span of 156 ft. 9 ins. and two approach spans of 86 ft. 6 ins., replaced with a double track bridge; (3) four pony lattice through bridges of 87 ft. span replaced with new through plate girder bridges; (4) three pony truss deck bridges of 56-ft. span replaced with new deck plate girder bridges.

The maximum grade between Chicago and Carbondale is 32 ft. to the mile. Between Carbondale and Fulton the maximum is 40 ft. per mile, and there are two points where approximately this grade exists: (1) The Mackanda Hill, which is about seven miles long and has 40 ft. to the mile as a maximum and 39 ft. as the ruling grade; (2) the approaches to the Cairo bridge, about 1½ miles long. The maximum grade between Fulton and Memphis is to be 26.4 ft. per mile. Between Memphis and New Orleans, via Greenwood, it will be 20 ft. per mile when the grade reduction now under way is completed. Between Chicago and Centralia the "300" type of engine (62 tons, exclusive of tender) is rated at 1,100 tons for train load at the most difficult points, while the "400" type of engine (63 tons) is rated at 1,350 tons train load. Over the larger part of the distance the latter type is rated at about 2,000 tons train load. These weights are for the train alone, between the tender and the caboose.

In addition to the bridge work heretofore mentioned, the following steel bridges have been put in to replace wooden structures or iron structures that were too light for the present traffic: At Normal, Ill., one single track through plate girder, 42 ft. long, across a street, replacing a pile trestle. At Champaign, one 50 ft span three track through plate girder across Green St., the street being depressed to avoid a grade crossing. Near Apple River, an iron bridge of three deck plate girder spans, each 60 ft. long, has been put in to replace a trestle bridge. Near Council Hill two pile trestles across the East Fork of the Galena River have been replaced with deck plate girder bridges, two of 30 ft. and one of 60 ft. span. Between Galena and Dubuque, iron spans have been put in to replace Howe trusses across the Sinsinawa and Menominee Rivers, the spans being 127 ft. and 99 ft. long, respectively. All these bridges have had concrete or stone masonry built to support them. The fixed spans of the Dubuque bridge are now being replaced. This bridge consists of two 250-ft. spans and three 225-ft. spans. The draw span was replaced in 1892.

As to the use of concrete in bridge work, the composition and cost of the concrete vary in different pieces of work. Natural cement is only used for concrete in foundations and below the ground line. Portland cement concrete is used in all exposed work, and the proportions are varied in different parts of the same structure. Only general information can be given as to the relative cost of concrete and stone masonry. Where there is only a small amount of masonry required concrete can be put in a great deal more cheaply than stone; but in places where a large volume of masonry is required, good stone masonry of coursed ashlar has been built at about the same price as first-class concrete work.

The track elevation of the St. Charles Air Line† in the city of Chicago was commenced in 1898, but was not completed till 1899. The I. C. R. R. is one-fourth owner in this line, which crosses the city from east to west near 16th St., from the lake front to the Chicago River.

The bridges now being built by the Illinois Central R. R. are designed according to Waddell's compromise system of live loads, using a typical engine called Class "R," followed by a corresponding load per foot of bridge. The weight of one engine and tender loaded is assumed to be 161.5 tons on 52 ft. in length; and the following load is 4,600 lbs. per lin. ft. of bridge.

In connection with the improvement of the western line, a new freight yard has been made at Freeport. This yard contains approximately three miles of track. There are six tracks of 2,000 ft. each, with lead tracks. Railway grade crossings at seven points have been equipped with interlocking plants during the past year.

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†Engineering News, April 13, 1899.

used for the abutments of a small bridge at Council Bluffs. All the bridges will be plate girder structures, designed for double track, one of the girders of each present single track span being designed as the middle girder of a double track span. The bridges were designed under the direction of Mr. W. H. Parkhurst, Engineer of Bridges and Buildings, of the railway company, and his department will undertake all the erection. The construction was let to the American Bridge Co., of Chicago, at pound rates.

Track.—The line is single track, but has long passing sidings, and it is expected that within a few years the line will have to be double-tracked, from Fort Dodge to Denison at least. Bridge girders and abutments are built for double track, as already noted. The main track is laid with 30-ft., 85-lb. rails of the Am. Soc. C. E. section, rolled by the Illinois Steel Co., and 67-lb. rails are mainly used for sidings. The rails are laid with square three-tie joints spliced by 44-in. angle bars and six bolts. Square joints are considered preferable to broken joints, except on the very best track with a well-settled roadbed and a full depth of good stone ballast. The 85-lb. rails are used for frogs and switches, and where these meet the 67-lb. rails of the siding the Atlas malleable iron step-joint is used, the bars forming a base support and splice and being set up with four bolts. This device is manufactured by the Atlas Railway Supply Co., 1654 Monadnock Block, Chicago. There are 18 ties to a rail length, the ties being of oak and costing about 35 cts. each. As these ties are hauled 300 to 500 miles over the company's road, however, it is estimated that they would cost other roads in the same section of the country about 75 cts. each. Split switches and spring rail frogs are used, and the switches are operated by high non-automatic switchstands. The cattleguards are of the surface type, with wooden slats, and have triangular apron fences close to the track.

The line is ballasted with 12 ins. of gravel, having a top width of 12 ft., and next year, when the banks have settled and the road has gone through its first winter, it will be reballasted from end to end, raising the track out of face, and giving at least 12 ins. of ballast under the ties. About 500,000 cu. yds. of ballast have been laid at a cost of about $1,500 per mile of single track, exclusive of sidings. Flat cars with plows and Rodger ballast dumping and distributing cars are used. The latter do the work more rapidly and effectively, and as they are all equipped with M. C. B. couplers and air brakes, the trains of 20 Rodger cars can be operated on a pretty fast schedule, being under full control. They thus work to better advantage and with greater economy. In wet and freezing weather, however, care must be taken that the wet ballast does not get frozen in the cars, as it is slow and difficult work to break up and shovel out the stuff. On flat cars, however, frozen ballast is more easily disposed of. The older Rodger cars have low sides (Eng. News, Feb. 17, 1898), and carry about 20 cu. yds. of gravel, but later cars used on this line have the sides carried up and will hold about 30 cu. yds. (Eng. News, Jan. 4, 1899). With flat cars, the trains have about 40 cars, with about 12 cu. yds. per car. Most of the engines used on the construction and gravel trains are of the mogul type.

There are four track crossings at grade: the C., R. I. & P. Ry., at Tara; the C., M. & St. P. Ry., at Rockwell City; the C. & N. W. Ry. (Boyer Valley branch), at Denison; and the C., M. & St. P. Ry. (Sioux City line), at Arion. Next year, when the roadbed has settled and become consolidated, these four crossings will be equipped with interlocking plants, and eventually all the grade crossings between Chicago and Omaha will be thus equipped in order to provide for a fast train service.

Yards.—At Tara, which is the junction point, will be a large "diamond" yard, enclosed by the diverging main tracks of the Sioux City and Omaha lines, and a connecting line between the two. At present this yard is used largely for storing and handling bridge and construction material, and only the alternate tracks have been laid, so as to leave plenty of room. At Wall Lake there will be a relay yard, and at Council Bluffs an extensive terminal yard.

Stations and Buildings.—There are about 21 stations on the road west of Tara, exclusive of Omaha, where the road will enter one or other of the two new stations, described in our issues of Jan. 12 and June 1, 1899. The most pretentious stations will be those at Council Bluffs and Denison, both of which will be of red brick, and the contracts for which have been let to the Geo. B. Swift Co., of Chicago. The first of these will cost about $50,000, and the other $13,000, or $17,000 including the freight house. All the other stations will be frame structures of two standard designs, modified slightly as to dimensions, according to the importance of the town. One design is for a single-story structure, where the operator can find quarters near at hand in the town. The other is for a two-story structure, where the town is at some distance, and the operator must have quarters at the station. At Council Bluffs there are a ten-stall brick roundhouse, a brick machine shop, oil and sand house, large water tank, coal chutes, and a 66-ft. turntable of the Illinois Central R. R. standard design, made by the Lassig Bridge & Iron Works, of Chicago. The roundhouse and machine shop are of pale pink brick, made from the Missouri River silt. At several of the stations, stock yards and loading chutes have been erected. Semaphore train order signals will be erected at the stations. The approaches will be well graveled and have sidewalks built, so as to give a neat appearance to the surroundings, and easy access to the station. At Wall Lake there will also be a coal chute and a wooden water tank of 100,000 gallons capacity, supported by a timber tower with concrete foundation pedestals.

Standard Designs of Frame Stations.—As already noted, there are two standard designs for the ordinary stations along the line, one being for single-story and the other for two-story frame structures, and plans and elevations of each are shown in our inset sheet.

The single-story station has the ticket office between the two waiting-rooms, with a ticket window to each room, and a window opening into a small room where trainmen get their train orders, etc. This is better than giving out train orders at an open window or allowing the trainmen to go into the agent's office for orders. Beyond the men's waiting-room is a freight room of such length as the business demands. The waiting-rooms are 16 ft. 0½ in. × 23 ft. 1 in., inside measurements, and the ticket office is 21 ft. 1½ ins. × 12 ft. 1 in., with track end projecting about 3 ft. 6 ins. from the face of the building, and having windows which give a view of the platforms. The space marked "Business Men" is for the use of teamsters, etc., having business with the agent, and who are thus excluded from the agent's office. The freight room has rolling doors. The roof is carried by simple wooden trusses, as shown by the cross section. The floor consists of a bottom course of ⅞-in. planks and a top course of ⅜-in. hard maple flooring.

Around the station is a plank platform 8 ft. wide at the rear, 10 ft. at the sides, and 18 ft. in front. This is of 2-in. plank, at right angles to the track, with a pitch of 4½ ins. in 18 ft., the top of the edge being 3 ins. above the head of the rail. The planks are carried on joists 3 × 10 ins., 12 ins. apart. These are supported by girders 8 × 8 ins., 10 ft. apart, resting on posts of the same size, each post having a footing piece 3 × 8 ins., 30 ins. long, under which are three transverse pieces 3 × 10 ins., 30 ins. long, parallel with the track. The inner end of the girder rests on a 3-in. plank spiked to the face of the 8 × 8-in. post of the building. The floor of the building is 15 ins., or two steps, above the platform. Beyond the plank platform at each end is a platform 12 ft. wide, formed of a bed of limestone screenings contained within a curling of timber 8 × 16 ins. The edge of the platform is 5 ft. 6 ins. from the center of the track.

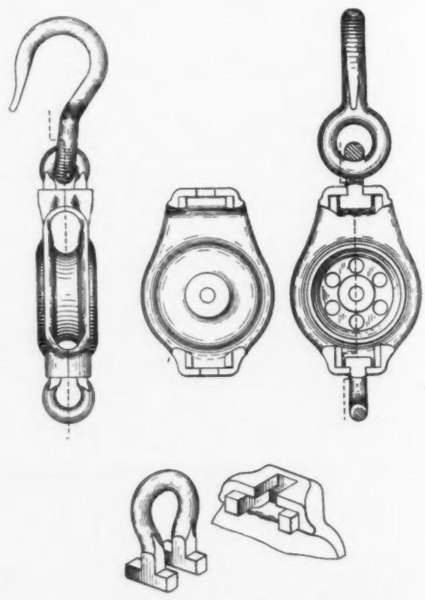
The two-story building is smaller, being used at less important stations, and is 50 × 16 ft. on the ground plan. It has a waiting-room 13 ft. 6½ ins. × 15 ft. 1 in. on one side of the ticket office, and the freight room on the other side. The living quarters above include a dining-room, kitchen and two bedrooms. The roof is carried by king-post trusses.

The buildings are of simple but neat and attractive design, and the outside sheathing is of clear white pine planks, placed vertically in the lower portion and horizontally in the upper portion. In the former, the planks are 1 × 4 ins., dressed, matched, beaded and center beaded. In the latter, the sheathing is of bevel siding, ½ × 4 ins., laid 3 ins. to the weather. The exterior walls are all 5½ ins. thick, having one inner course of sheathing and two outer courses, the latter having tarred paper laid between them. The foundations are posts 8 × 8 ins., with plank footings. The roofs have a pitch of 9 ins. to the foot, and are covered with 1⅛-in. roof boards, on which is a single layer of No. 2 Cincinnati tarred roofing felt, weighing 15 lbs. per ft. Over this is the exterior covering of "Jackson Bangor" slate, 10 × 8 ins., laid 7½ ins. to the weather, each plate being secured by two yellow metal nails. On the ridge is a cresting of No. 22 galvanized iron. All gutters, down spouts, flashings, etc., are of galvanized iron. The standard color scheme for all stations, section houses, boarding houses, etc., is in two shades of light green, with a third shade formed by mixing sand with the paint. This "sand paint" is used at about the height at which loungers are in the habit of amusing themselves by whittling the boards, and the sand has a decidedly discouraging effect upon this destructive amusement. The designs for the stations were made by Mr. Francis T. Bacon, Architect for the Illinois Central R. R., and the erection was done by the railway company, under the supervision of the Master Carpenter of the road.

A NEW TACKLE-BLOCK.

The tackle-block here illustrated is intended to simplify construction, decrease cost of manufacture, increase strength and diminish the wear on the rope used. It is the invention of Mr. A. B. Tarbox, of the Boston & Lockport Block Co., of Lockport, N. Y.

In this block the cheek-pieces are either made by casting, or by striking-up sheet metal; and the parts are so formed and connected that they can be assembled in a perfect block without fitting or



A New System of Tackle-Block Construction.
The Boston & Lockport Block Co.

machine work of any kind. In the single-block here shown the metal cheek-pieces are provided at their upper and lower ends with lateral interlocking lugs and extensions, projecting inward, and thus form the shell of the sheave. The square shanks of the upper and lower shackles interlock with the interlocking cheek-pieces in such manner that when any strain is put upon them the tendency is to draw the ends of the cheeks together. The patent drawings show various methods of ar-

delays; in the maintenance of way department, from the roadmaster to the section man, the constant thought is to make the track safe for this special service. In other words, the entire character of the service is keyed up to a necessarily high pitch, which, while accruing in a measure to the benefit of the other service, nevertheless adds expense which it is impossible for any man more than to guess at. It is, of course, unnecessary to add that the best locomotive and car equipment is used in such trains.

(2) The added cost of wear and tear of machinery, rolling stock and track is noticeable. It has often been noted that on a new piece of track a heavy engine hauling a high speed train will often do an immense amount of damage in throwing out of line and surface, a track which has stood up satisfactorily under a number of heavy though slowly moving trains. With old track in good condition the difference in the effect of high speed as compared with slow trains, is of course very much less noticeable, but that the difference exists nobody of experience doubts. The best evidence of the added cost of wear and tear of the machinery is shown in the records of engine failures which are kept by many railways. It has been found that by keeping these failures divided between freight and passenger service, the fact is disclosed that the failures of engines in passenger service are in much greater ratio to passenger train mileage than the failures in freight service, and this in spite of the fact that the best motive power equipment is used in passenger service. A still further analysis of these failures shows that an overwhelmingly large proportion of the failures in passenger train service occurs in special fast passenger and mail trains, the failures in light and slow passenger service being almost nil.

(4) In spite of the care that must be used, the risk of accidents, breakage of machinery or failure of track and structures cannot be lost sight of. What this risk is worth in terms of an insurable quantity would take an actuary with statistics covering years of actual performance to determine. Eternal vigilance has sufficed to reduce accidents in high speed service to a comparatively low figure, but how terrible in consequences such accidents can be is too well known to railway men to dwell upon.

(5) The risk of accidents to other trains is also an unknown quantity which is most difficult to determine. It may operate in several ways. The effect of a collision, it is known, varies as the square of the velocity, but it is not only in collisions that the risks are great. There are many other small and elusive ways in which this item operates. Take the case so familiar to railway men who have had experience in the engine or train service, of a freight train trying to get in on a side track to clear some special train. There may be a hot box on the train requiring attention, but the engineman and conductor looking at their watches see that they must hurry or have an explanation to make. The box is allowed to go with perhaps scanty attention, and a risk is taken which once in a while results fatally. Accidents from collisions of trains are fortunately rare on good trunk lines, but the character of the service required to avoid them is of the highest class. There would be small necessity for the expensive block and signal systems were it not for the excessively high speed trains. Divisions of railway on which such trains are not run, are, we know, successfully operated without them, and the expense of all such safety appliances does not enter so much in the first cost as in the cost of maintenance and renewal, and the wages of employees attending them.

(6) The delay to other traffic due to high speed trains, while a most difficult factor to determne, is to my mind perhaps the most serious one. I remember reading an article by Mr. Ely, now Chief of Motive Power of the Pennsylvania System, which appeared in Scribner's Magazine in 1892, in which he discussed, as I recollect it, in a very interesting way, the possibility of operating trains at excessively high rates of speed. It was at a time when there was more or less discussion as to whether it would be possible to build a locomotive that would run 100 miles an hour and whether, when it came to making such high speed as this, electric motors would not displace locomotives. The point that Mr. Ely made was that while it might be entirely feasible to design a locomotive to make such a speed, the real difficulty was a transportation difficulty. He showed by a number of illustrations that it would practically mean an independent track, and, of course, in figuring the cost of operating such a train, the interest on the value of the track and right of way to which it must have exclusive use would have to be taken into consideration.

It has been pointed out a good many times by practical railway men that the way to do a maximum amount of business over a piece of railway is to have the speed of all trains as nearly uniform as possible. The most familiar examples which we have in our daily lives, of the carrying capacity of a railway moving its trains at a relatively slow but uniform speed and at frequent intervals, are the street car lines and elevated roads. When we read the statistics of business done by street car lines and elevated roads on holidays, and compare them with the numbers handled by steam roads we are sometimes astonished at the difference. The steam road handling its long trains at infrequent intervals cannot begin to do the business of the street car line or elevated road with its frequent trains following each other even at a much more moderate rate of speed.

A fast train following a slow one soon catches up with it or, as the expression goes in railway parlance, "runs over it." The slow train must take a side track. This takes time, and furthermore an allowance or clearance must be given between the trains to provide for safety. Reversing the case, a slow train following a fast one, lags behind it and leaves a big gap, during which time the railway is unoccupied. The high speed train in just the ratio which its speed exceeds that of the other train, makes a gap in front and behind it, during which time it has the exclusive use of the track. Take a simple illustration of three stations (A), (B) and (C), located 30 miles apart; a train leaving (B) at 30 miles an hour is caught by a train leaving (A) at the same moment, but running at 60 miles an hour, just as the two trains reach (C). As this would not be a practical way to operate, an allowance must be made to permit the slow train to side track and also provide a safe interval of clearance between the trains. Hence it is obvious that the slow train leaving (B) must leave the full amount of time for side tracking and clearance ahead of the fast train leaving (A). Cases such as this and much more complicated, especially in the case of a single track railway, are a mere commonplace in railway operation, and in many cases there is a much greater divergence in the speeds of trains considered than in the illustration suggested.

I remember that at the time a special fast train was put on an important trunk line it was said that the running of the train was fully justified by the fact that the train earnings were more than twice the average passenger train earnings of the road, but many shrewd and conservative men said that the true expense had not been fully considered, and it was further pointed out as an actual fact the passenger and freight service of the road was, to a great extent, paralyzed by the fast special train. It is quite certain that it must have impaired the capacity of the railway to handle business.

There are other ways too indefinite to classify, in which specially fast service has increased the cost of transportation in general. It has led to the construction of larger and more powerful engines, and has educated the public as well as railway men to the point where the old fashioned speed of 20 to 30 miles an hour is considered slow even for freight. More powerful engines have, of course, brought about some economy in greater tractive power, but the greater power and greater ability to handle trains at speed has encouraged to some extent a laxness in engine, train and yard men. How often one hears the expression when a passenger or freight train leaves any station behind time, "Oh! that is nothing, we can easily make that up." Every railway officer knows that the general speed of all trains has greatly increased in ten years; few of them know how rapidly many of their trains are run between stations.

Steam railways have done most to educate the public to this demand for speed, but there have also been other forces at work. In the domain of urban and interurban transportation there has been an astonishing change. Cable cars which once seemed rapid as compared with horse cars are now thought slow in comparison with electric cars. What the limit of speeds will be, and whether it is best for the human race that the speeds of transportation be increased is not within the province of this paper. The point I wish to enforce is, that speed costs heavily, but just how much I am not prepared to say. The general superintendent of an important trunk line recently gave the cost of operating an extra fast train as $2 per train mile. How this figure was reached I do not know, but, at a guess, I should say it was none too high. I must close my paper with the question expressed in the title still unanswered, and with the hope that some one else better qualified can answer it.

Discussion.

The discussion turned very largely on the question of fuel consumption at high speeds, and Prof. Goss pointed out that the rate of combustion per hour would increase as well as the consumption per mile, so that both together would very likely increase the fuel consumption 100% in an increase of speed from 30 to 60 miles per hour. Mr. Deems thought that fast running might really be an element of safety, owing to the way in which officers and men were "keyed up" to do their best to provide for the safety of the trains. Mr. E. E. Russell Tratman (Engineering News) pointed out that there are practically no figures available as to actual cost of train operation. There are averages in plenty, but these are practically useless, as they include trains of all kinds in all kinds of service. He thought it would pay railways to investigate this matter, taking, perhaps, two trains (one fast and one slow) on one division as a beginning, and so obtaining actual figures on which to base estimates and calculations. As an example of the little value of averages in such a matter, be stated that the heaviest average freight train load, according to official reports from various railways, is 452 tons, on the Chesapeake & Ohio Ry., whereas everybody knows that many roads are operating trains of 1,000 to 3,000 tons in actual practice. He thought it ought to be possible to ascertain the cost of transportation in the same way that the cost of manufactured articles is worked out in railway shops and manufacturing establishments. Mr. G. W. Rhodes (B. & M. R. R. R.) endorsed the above statements and thought it quite time that railway men should investigate these matters and at least get some fair idea of what train service costs. He thought the matter should be no more difficult than was the investigation and solution of the car coupler problem. On motion of Mr. Rhodes, a resolution was passed to the effect that the paper should be submitted to the American Society of Civil Engineers, American Society of Mechanical Engineers, Railway Master Mechanics' Association and Master Car Builders' Association, with a request that the subject be taken up for discussion and investigation.

TABLE SHOWING THE LOSS OF PRESSURE IN STEAM PIPES.

By A. F. Nagle,* M. Am. Soc. M. E.

1 Boiler Horse Power = 34.50 lbs. of water evaporated from and at 212° F. per hour. Formula [Kent, p. 617]:

$$p_1 - p_2 = \frac{Q^2\ w\ L}{C^2\ d^5}.$$

p_1 and p_2 = pressures at beginning and end of pipe,
Q = cubic feet of steam per minute,
w = weight of 1 cu. ft. of steam,
L = length of pipe in feet = 100 ft.
d = diameter of pipe in inches.
C = constant = 65 or C^2 = 4,200.

This formula will reduce to

$$p_1 - p_2 = \frac{.00787\ V \times HP.^2}{d^5},$$

when V = volume in cubic feet of 1 lb. of steam at required pressure, and HP. = Horse Power.

For 100 lbs. pressure V = 3.82
" 150 " " V = 2.72
" 200 " " V = 2.12
" 250 " " V = 1.73

The formula then becomes for

100 lbs. steam pressure, $p_1 - p_2 = \frac{.0300\ HP.^2}{d^5}$;

150 lbs. steam pressure, $p_1 - p_2 = \frac{.0214\ HP.^2}{d^5}$;

200 lbs. steam pressure, $p_1 - p_2 = \frac{.0167\ HP.^2}{d^5}$;

250 lbs. steam pressure, $p_1 - p_2 = \frac{.0136\ HP.^2}{d^5}$.

Loss of Steam Pressure in Flowing Through 100 ft. of Pipe.

Boiler, HP.	Diameter of pipe.	Steam pressure, lbs. per sq. in. 100.	150.	200.	250.
100 HP...	2½ ins.	3.0	2.2	1.7	1.4
	3 "	1.2	.90	.70	.57
	3½ "	.57	.40	.32	.27
200 HP...	3 "	5.0	3.6	2.8	2.3
	3½ "	2.3	1.6	1.3	1.1
	4 "	1.2	.84	.66	.54
300 HP...	4 "	2.6	1.8	1.5	1.2
	4½ "	1.5	1.1	.83	.68
	5 "	.86	.62	.50	.40
400 HP...	4½ "	2.6	1.9	1.5	1.2
	5 "	1.5	1.0	.88	.72
	6 "	.62	.44	.35	.30
500 HP...	5 "	2.4	1.7	1.4	1.1
	6 "	.97	.69	.54	.45
	7 "	.44	.32	.25	.21
600 HP...	5 "	3.5	2.5	2.0	1.6
	6 "	1.4	1.0	.78	.65
	7 "	.64	.46	.36	.30
800 HP...	6 "	2.5	1.8	1.4	1.2
	7 "	1.2	.82	.64	.53
	8 "	.60	.42	.33	.28
1,000 HP...	7 "	1.8	1.3	1.0	.83
	8 "	.91	.66	.51	.42
	9 "	.51	.36	.29	.23
2,000 HP...	9 "	2.1	1.5	1.2	.94
	10 "	1.2	.86	.67	.56
	12 "	.47	.33	.27	.22
3,000 HP...	10 "	2.7	2.0	1.5	1.3
	12 "	1.1	.75	.61	.50
	14 "	.50	.36	.30	.23
4,000 HP...	10 "	4.8	3.5	2.7	2.3
	12 "	1.9	1.4	1.1	.88
	14 "	.90	.64	.50	.42
5,000 HP...	12 "	3.0	2.2	1.7	1.4
	14 "	1.4	1.0	.80	.65
	16 "	.75	.53	.41	.34
7,500 HP...	14 "	3.2	2.3	1.8	1.5
	16 "	1.7	1.2	.90	.75
	18 "	.90	.63	.50	.42
10,000 HP...	16 "	3.0	2.0	1.6	1.4
	18 "	1.6	1.2	.90	.74
	20 "	.94	.67	.53	.44

DUTY ON ELECTRICITY brought to the United States across the Niagara River is disturbing the Merchants' Exchange at Buffalo. The Treasury Department says it has taken no action in the matter, as it has only been brought to its attention as a hypothetical question. If subject to any customs duty, says Assistant Secretary of the Treasury Spaulding, it would be as an unenumerated, unmanufactured article, with duty at 10% ad valorem.

*Mechanical Engineer, Manhattan Ry. Co., 32 Park Place, New York city.

NEW SEWAGE FARM FOR THE ST. DENIS WARD OF MONTREAL.

The St. Denis Ward of the city of Montreal has 376 acres of its area lying north of the height of land and sloping towards the Rivieres des Prairies, or Back River. It being impossible to connect this area with the city sewers, discharging into the River St. Lawrence, without great expense and the construction of a new main sewer, it was decided by the road committee, with the sanction of the city council, to establish a sewage farm. Accordingly, the city bought 20.77 acres of farm land. After deducting a 20-ft. roadway from this area, 20.05 acres are left, which the city authorities believe should be ample to care for the sewage of 12,000 people, a population in excess of that to be expected in the ward for many years to come.

The city paid about $6,000 for the 20.77 acres of land, and let the contract for the development of ten acres, including a screening chamber, other accessories and a little work on the other half of the area, to Mr. Geo. Janin, C. E., for $16,191. A few changes in detail increased the cost to $16,876. The contractor is to have the use of the farm and take care of the sewage for the next ten years, after which the improvements become the property of the city, and it is expected by the city authorities that sewage farming will be practiced with success and give good results and fair remuneration. It will be noted that the land can also be used for intermittent filtration. The soil, however, which is a sandy loam, will probably limit the application of sewage to a low rate, even if there were no crops to do so.

The farm is located in the parish of St. Laurent, at a distance of 10,000 ft. from Belanger St., the lowest street in the ward, and in which the main sewer is located.

The outlet sewer is 2×3 ft., egg-shaped. For a distance of 3,500 ft. north of Belanger St. it has a grade of only 1 in 1,000, but from this point the

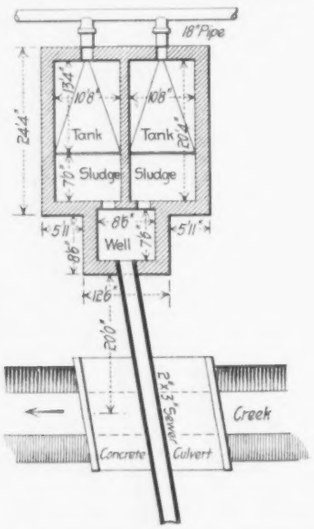


Fig. 1.—Plan of Screen Chamber for the Sewage Farm, Montreal, Que.
Percival W. St. George, City Surveyor; Geo. Janin, Contractor.

grades are steep, ending with 1 in 600 at the screen house. The excavation has been nearly all through rock. The contractors for the main sewer are Messrs. Keegan & Heffernan, of Montreal, the cost being about $44,000.

The main sewer, after crossing a ditch on a concrete culvert, enters the well of the screen house, Fig. 1, which well is about 8 ft. sq. The sewage then passes through two 2-ft. openings, with iron lift gates, operated from the floor above, into two screen chambers. The screens are 6 ft. high, made of ¼×1-in. vertical iron bars ½-in. apart. These bars pass loosely through 3-in. horizontal bars, so that the sludge may be scraped from above, and if necessary the bars may be withdrawn. The screen house is of brick, tarred where underground. It has a concrete floor and its walls are finished smooth inside, with cement.

The 18-in. outlets from the screen chambers are also provided with lift gates. They connect with an 18-in. sewer pipe, extending east and west of the tank house for a total length of 265 ft.; bends are then made to the north, and the pipes carried to the end of the ten acres. They are laid on the natural surface of the farm and are protected by embankments about 5 ft. high. These embankments divide the area into three parts, as shown by Fig. 2, which is a plan and cross-section of the ten acres already developed. The whole area is surrounded by embankments 2 ft. high, with cross banks of the same height at right angles, subdividing the area into 33 beds, each about 125×75 ft.

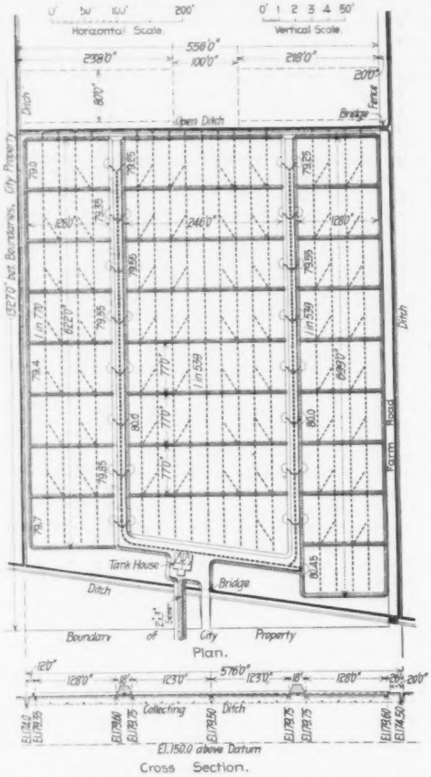


Fig. 2.—Plan and Cross-Section of Developed Portion of Sewage Farm, Montreal, Que.

The sewage is distributed on to the beds from the 18-in. pipes through 9-in. tile branches with earthenware valves made by the Doulton Co., of London. The outlets are protected by concrete aprons. Each bed is graded on a slope of 1 in 500 from the outlet pipes. The subsoil is drained by 3- and 4-in. agricultural tile, placed 4½ ft. below the natural surface. The tiles are laid with butt joints, and covered with 12 ins. of charcoal, the remaining trench filling being sandy loam. These underdrains are placed 20 ft. apart longitudinally of the farm, with diagonal branches connecting every pair, on a grade of about 1 in 540, and leading to a semi-circular brick sewer at the end of the ten acres. The effluent flows from this sewer to and through a ditch discharging into the Back River, a total distance of about 1½ miles.

The other ten acres has been surrounded by a small embankment, with the necessary cross ditches, but has not been subdrained, nor divided into beds. It will be completed as necessity requires.

In order not to drown out the sewage farm during freshet times, or in case of any accident to the main, provision has been made to pump the sewage into the existing city sewer, the pumps being operated by electricity and automatically.

We are indebted to the City Engineer, Mr. Percival W. St. George, and to his Deputy, Mr. John R. Barlow, for an opportunity afforded to a member of our editorial staff to visit the disposal area on Oct. 6. The farm was then practically ready for use, so far as it will be developed at present, but the lateral sewers and house connections had not been laid.

The plans for the entire work were made under Mr. St. George's supervision by Mr. Stuart Howard, C. E., who has had charge of the laying out and the superintendence of both the sewage farm and the main sewer.

WHAT DOES IT COST TO RUN TRAINS AT HIGH SPEED?*

By F. A. Delano.†

A good deal has been said and written in the last year or more about the phenomenally high speed made in this and other countries, and superintendents of motive power, mechanical engineers, and locomotive builders have all pointed with justifiable pride to the records made by particular engines. The writer was recently asked by a superior officer to tell at short notice, how much more it cost to operate a train scheduled at a very high rate of speed, than a train at a moderate rate of speed, and after studying the matter over carefully for some hours, came to the conclusion that an answer to the question was so complcated a one that it could only be made in general terms.

When asked by the officers of the Western Railway Club to write a short paper at short notice, I could think of no question which needed an answer so badly, and no question which would be of more general interest to railway and mechanical men than the question of the cost of running high speed trains. In a general way the subject has been pretty constantly in the minds of operating officers of railways, but when we come to answer the question in figures, how few data are at hand to assist us!

For convenience we will group these items of cost of operation, which are increased with high speed as compared with moderate speed service, under the following headings:

(1)—Increased fuel consumption.

(2)—Higher grade or standard of machinery, material and service required for extra fast trains.

(3)—Increased wear and tear, cost of maintenance of machinery, permanent way, etc.

(4)—Increased risk of accident by breakage of machinery, injury to track, etc.

(5)—Increased risk of accident, such as collisions with other trains, and risks taken to avoid collisions.

(6)—Delay to traffic on account of keeping the road clear.

(1) The ordinary formulas for train resistance would indicate that the cost of operating a train at, say 60 miles per hour, as against 30 miles per hour would entail an increased fuel consumption of something like 62½%. This is determined by the Baldwin Locomotive Works formula: $R = 3 + 1\text{-}6\ V$. The figures, which I have been able to get at short notice, indicate that the increased fuel consumption per car or ton is much greater than this, and certainly proportionate to the speed. This is largely due to the fact that a locomotive cannot be operated as economically at higher speed, and that if designed with a special view to economical operation at very high speeds will have a very diminished tractive power. By way of illustration, I may cite a very interesting series of indicator cards I recently saw, taken from an engine to determine the steam distribution in the cylinders at the same cut-off, but at speeds varying from 20 to 57 miles per hour. Although the cards were considered as making a most satisfactory showing, the drop in the mean effective pressure was astonishing. The figures showed a drop of 42% for an increasé of 30 miles per hour in speed. A more familiar way in which the same fact is forcibly brought to our attention is the recollection that a class of engines which formerly handled trains of ten to twelve cars successfully on many of our trunk lines ten years ago, is now discarded and put on branch or light service, and engines of more than twice the power do not handle as long trains. Obviously the difference is due to the enormous increase in the demand on engines in the way of speed. Futhermore, in comparing engines of to-day with those of ten or fifteen years ago, it will be noted that the increase in boiler capacity has been much greater than the increase in cylinder dimensions.

(2) In extra fast service, no expense, one may say, is spared to prevent breakdowns, detentions, or failures of any kind. Even the waste which is put in the oil boxes of cars and engines is of a special quality; the journals are burnished; the brasses are specially scraped or machined; the coal which is put on the tanks is selected coal, broken in advance so that the firemen will not be obliged to break it. The locomotive itself is looked over by the best mechanics, and the master mechanic gives a large share of his thought and attention to the condition of the engines and cars in such trains. In the superintendent's and despatcher's office special attention is given to avoid

* Abstract of a paper read before the Western Railway Club, Jan. 16.

† Superintendent of Motive Power, Chicago, Burlington & Quincy R. R.

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ADVERTISING RATES: 20 cents a line. Want notices, special rates, see page XXI. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.

A curious illustration of the economy with which modern commerce and transportation is conducted is given in a report of the "Foreign Markets" section of the Department of Agriculture. It is there stated that the farmers of Denmark find it profitable to buy American bacon and butter for their own consumption and send that which they themselves produce to the English markets, where by reason of its long established reputation it commands a higher price than the American product.

Another example of a similiar sort, but which also shows the phenomenal advance in iron prices which took place last year was the experience of a prominent export house in New York city. In 1898 this firm shipped a lot of pig-iron to Japan. The grade sent was found to be unsuited to the Japanese market, however. The demand there is said to be for a soft iron which can be readily broken up into small pieces for use in the primitive forges, and the American pigs proved difficult to fracture in the customary way. Most of the shipment was therefore returned to the New York export house. By the time it reached here, however, the price of iron had risen so much that, after paying the-freight on the consignment half way round the world and back again, the exporters still made a profit on the transaction.

In the matter of the position of street signs on lamp posts, the New York authorities have lately adopted a system which is about as unsatisfactory as could have been devised. Taking as an example a sign at the corner of Broadway and 12th St., the "Broadway" sign is set at right angles to that street and the "12th Street" sign is parallel with Broadway. The reason advanced is that the traveler in a surface car "knows that he is on Broadway, and only seeks the name of the street crossing Broadway." The truth of the matter that the traveler in the surface car, if he is hunting for some particular cross street—and is not depending upon the conductor, as the stranger usually does, will try to see the street sign before he comes to the crossing; and, this is just what he can not do under the present system. He does not see the sign he wants until he is passing it. To the stranger using the footways the new style is utterly bewildering; and if he is unacquainted with the new idea he is most likely to take the wrong street. To the resident New Yorker the scheme is equally provoking; it is most convenient for him to look for the name of the cross-street as soon as he comes within range of the lamp, as he may want to pass down the nearest side and the one opposite the lamp. But under the present arrangement he must walk over to the lamp, examine a sign awkwardly placed far above the eye-line, and then go back to the other side of the street—if that should be the side he wants. We all recognized the trouble occasioned by the old lamps that were so made that they could revolve around their central support, and thus, by accident, sometimes reversed the street-signs. But this is exactly what has now happened—by design, to every street sign indicator in New York. The originators of this scheme have given a sufficiently convincing object-lesson, in showing "how not to do it;" now, let them put the signs back again in the position with which all are familiar.

A NEW OUTLET FOR ANTHRACITE COAL TRAFFIC.

It begins to look as if the anthracite coal operators were likely to be successful in their attempt to secure a new railway outlet from the Pennsylvania anthracite fields to tidewater. As reported in this journal some weeks ago, a company has been incorporated in New York, under the name of the Delaware Valley & Kingston Ry., to build a railway line from Kingston, N. Y., on the Hudson River, along the line of the abandoned Delaware & Hudson Canal to Lackawaxen, Pa., a distance of about 81 miles.

The directors of the company are: Messrs Samuel D. Coykendall, of Kingston, N. Y.; Edward L. Fuller, of Scranton, Pa.; James N. Jarvie, Frederick P. Olcott, John W. Sterling, Samuel Thorne, William V. S. Thorne, George G. Williams, of New York city; and Walter Ferguson, of Stamford, Conn. The officers are: President, William V. S. Thorne; Secretary and Treasurer, George H. Church; Chief Engineer, Charles E. Webster, M. Am. Soc. C. E., late Chief Engineer of the Lehigh Valley R. R.

Mr. Coykendall is identified with large transportation interests on the Hudson River. Mr. Williams is well known as the President of the Chemical National Bank of New York, and Mr. Olcott is equally well known as the head of the Central Trust Co. Mr. Thorne is Vice-President of the Erie & Wyoming Valley R. R., of Pennsylvania, of which the new line will really form an extension.

It will be evident from the above list of names that the new project is backed by men of high financial reputation, and there seems every reason to believe that it will be carried to early completion. Work is already in progress on the construction of branch lines from the Erie & Wyoming Valley R. R. to collieries in the Lackawanna and Wyoming districts, and a large volume of traffic seems certain to be ready for the new line when it shall be completed. In this connection it is of interest to note that the E. & W. V. R. R. carried a traffic of nearly 3,000,000 tons in the year ending June 30, 1898. It is also stated that the Pennsylvania Coal Co. is strongly interested in the construction of the new road and has offered to the independent coal operators in the Wyoming and Lehigh regions contracts for the purchase of their product, paying 65% of the tidewater price for chestnut and larger sizes, 50% for pea coal and a flat freight rate of 85 cts. for buckwheat and smaller coals. This latter rate would be equivalent to a freight rate of 3.7 mills per ton-mile, taking the total distance from the collieries to New York via the new route at 230 miles.

The project for an independent railway line to the anthracite coal fields is an old one; but it is only in recent years, since the growth of the independent mining interests in the anthracite region, that it has had any probability of realization. The combination of the railways tapping the anthracite region is an old story. How it has been effected at different times and what vicissitudes it has been subject to are of little importance. The net result has been that the anthracite coal brought from the mines to tidewater has yielded to the railways a revenue larger than has ever been justified on the basis of the cost of carriage and the capital invested in the business. In recent years, we believe, the charge for anthracite coal has been in the vicinity of 1 ct. per ton-mile, while the rates on soft coal and similar bulk freights, when handled in large quantities over long hauls has often averaged less than half this figure.

The theory that railway rates should be left for competition to regulate has been fully tried in the anthracite coal business. Eight different railway companies have lines reaching from the anthracite fields to tidewater, a sufficient number to insure competition if it can ever be insured to the railway service. Legislation has been tried to foster competition, and state commissions and the Interstate Commerce Commission have lent their aid to keep it alive. To say that there has been no competition among the anthracite carrying companies would be untrue; but we believe it is safe to say that this competition has never secured the "reasonable rates" for the carriage of anthracite, to which producers and consumers are fairly entitled. Such competition as has taken place has resulted chiefly in the giving of secret rates and rebates, and in benefiting favored shippers and corporation officers "on the inside." The fruit of adherence to the theory of free competition in fixing railway rates on anthracite coal then, has been the transfer of many million dollars a year from the pockets of coal users, and to some extent of coal producers, to the pockets of those interested in the railways which carry this traffic.

And now let us inquire how great a factor this new route, assuming its eventual completion, is likely to prove in the reduction of these excessive charges on anthracite coal. We have small faith, as a rule, in all projects for building competing railways to reduce rates; for it is only a question of time, and usually but a short time, before the new competitor is bought up by the older and stronger companies, and the public is merely saddled with a new burden in the way of fixed charges.

Again it is to be remembered that the new road will tap only a small portion of the anthracite field, and can, therefore, reach only a limited number of the mines owned by independent operators. Its owners, moreover, may decide that it is better financial policy to "join the pool" and maintain rates at the old level than to undertake the horizontal reduction in rates for which the anthracite operators have looked so long and so earnestly.

It would be premature, therefore, to conclude that the new road is certainly going to meet the demands of the coal miners or remove the extortionate tax on the millions of anthracite coal users which has so long been endured. As the journal published by the Anthracite Coal Operators' Association says: "The new road will not be a solution of the anthracite coal problem. Nothing would do that except a radical change in the management of several anthracite railroads."

On the other hand, the coal operators are, to a certain extent at least, directly interested in the construction of its road, and in so far as they can control its policy after completion, their present desires are likely to be carried out. If the new road can preserve an independent existence for a few years even, and establish a lower standard of freight rates on anthracite, it will be difficult to again advance these rates to the old level. Such a reduction would confer an enormous benefit on the millions of users of anthracite coal throughout the East, however unwelcome it might be to the holders of stocks of the older coal carrying railways.

The New York Railway Commission is to give a hearing on Jan. 30 upon the petition for its certificate of approval for the new road, and it will very likely prove the most important case of this sort that has ever been brought before the com-

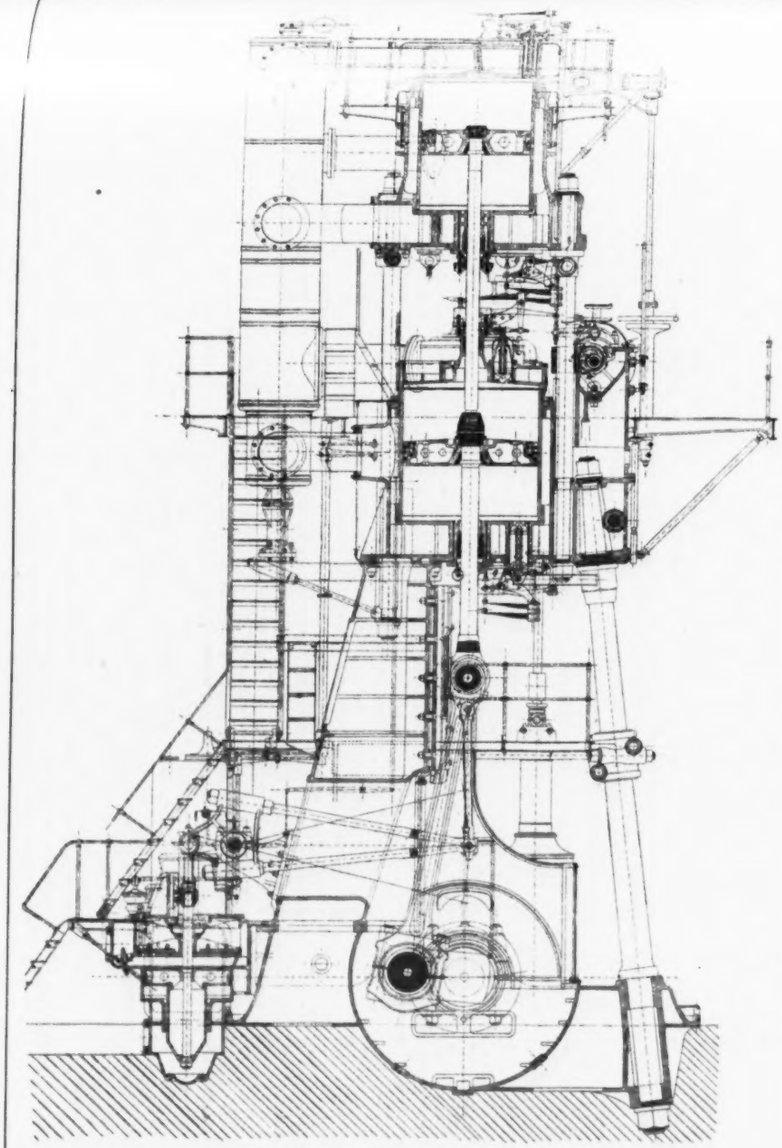


FIG. 1. SIDE SECTIONAL ELEVATION.

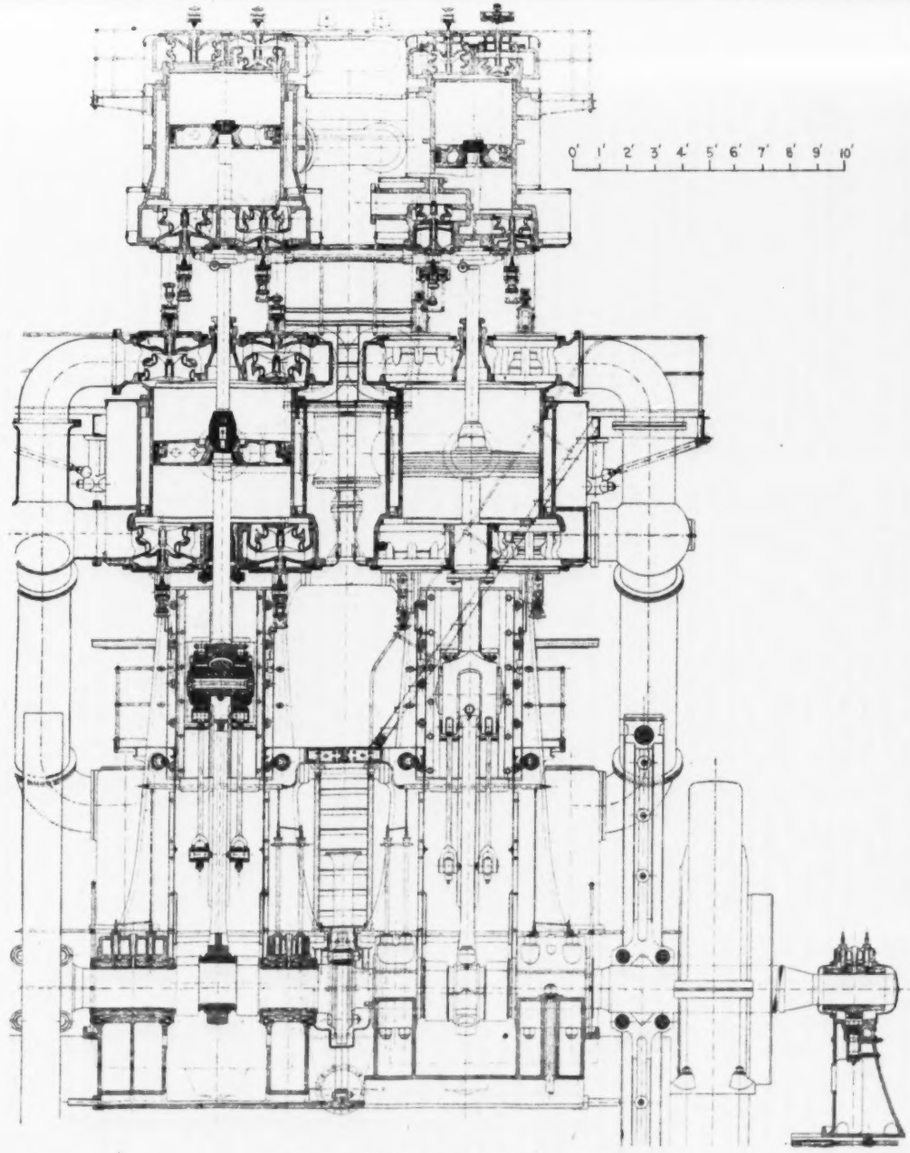


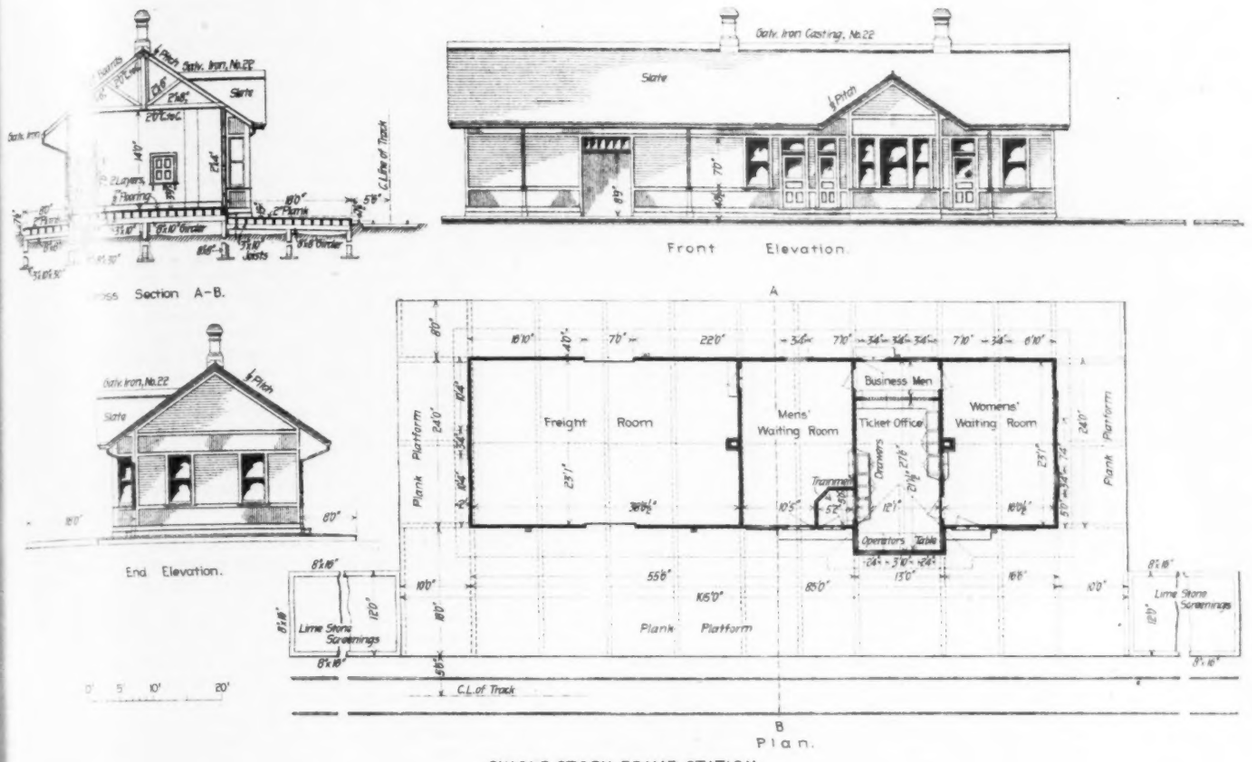
FIG. 2. FRONT SECTIONAL ELEVATION.

3,000 H-P. VERTICAL TRIPLE-EXPANSION ENGINE.

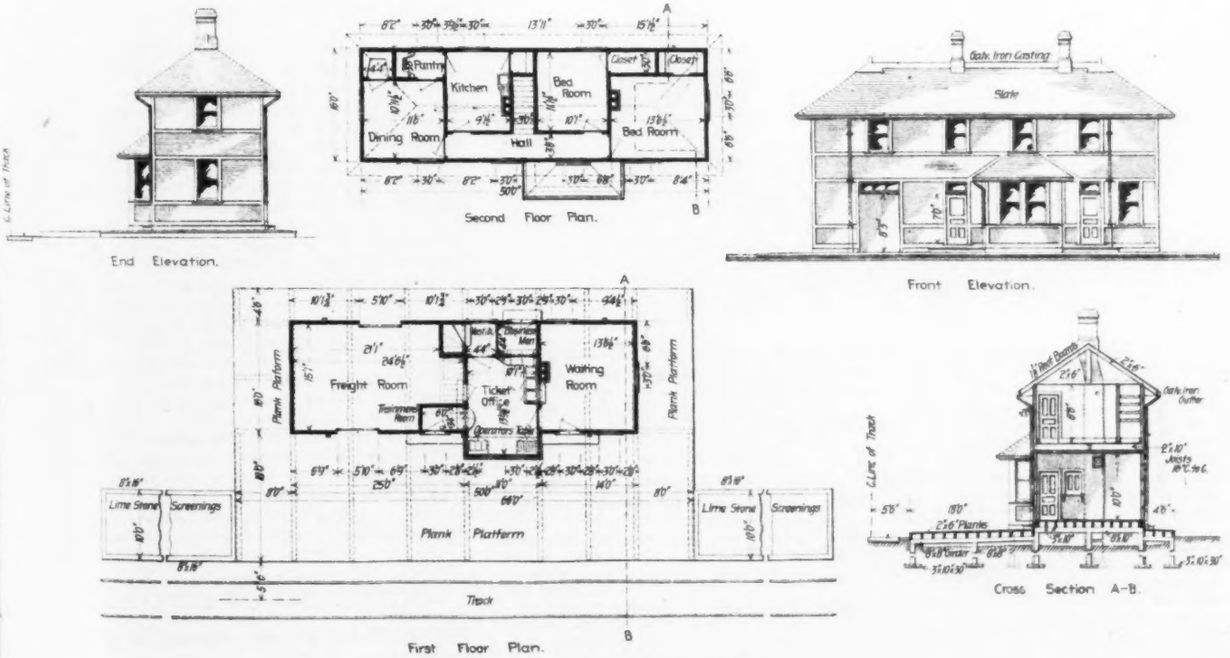
"Luisenstrasse" Station of the Berlin Municipal Lighting System.

Built by Sulzer Bros., Winterthur, Switzerland.

CHAS. HART, LITH., 20 VESEY ST., N. Y.



SINGLE STORY FRAME STATION.



TWO-STORY FRAME STATION.

STANDARD STATION BUILDINGS, FORT DODGE & OMAHA R. R., ILLINOIS SYSTEM.

Francis T. Bacon, Architect, Illinois Central R. R.

mission. Could the existing railways come before the commission and show that their rates on anthracite had been reasonable in the past, they might perhaps be successful in proving that "public necessity" did not require the construction of the new road; but we doubt whether they will attempt this. The fact that the new route takes the place of the old Delaware & Hudson Canal, and passes for part of its length through a country which is now without transportation facilities, is pretty certain to cause the commission to approve the enterprise.

From one standpoint the new line may seem a roundabout route from the anthracite fields to New York, but the distance is partially offset by the very favorable grades. It is said that it will be possible to move train loads of 2,000 tons from the collieries to the terminus at Kingston. Here connection can be made with the West Shore Road which, with its ample terminals at Weehawken, should be able to handle a very large coal traffic. The bulk of the coal, however, will doubtless go by water from this point, and as the depth of the Hudson from New York to Kingston is sufficient for large ocean steamers, the cost of this haul should be very small. It is true that the Hudson is closed by ice during part of the winter; but the ice is not so heavy that it would be a difficult or expensive matter to move barges through it, with an ice-breaking propeller to tow them, during any save the most severe winter weather.

A feature of great interest to engineers in connection with the proposed railway is that it follows for the whole distance the line of the old Delaware & Hudson Canal. We know of no more convincing object lesson of the superior economy of the railway to the canal as an agency for handling bulk freight than that here presented. As our readers will remember, the Delaware & Hudson Canal Co. decided a year ago to abandon its famous old canal, as it was found more costly to transport its coal to the New York market over it than to turn it over to the Erie R. R., and haul it over the by no means favorable grades of that road to tidewater at Jersey City. Now comes a new company, purchases the old canal and uses its right of way for a railway line to move exactly the same class of traffic that the canal was built to carry.

The public has often been told by the canal enthusiasts that the reason for the decay and disuse of the old time canals was the machinations of the railway companies which competed with them, or the neglect of the public officials in charge, where the canals were under state control.

In the present case, however, the entire transaction has been in the hands of private corporations. The Delaware & Hudson Company had no motive whatever for abandoning its old canal, except the fact that the cost of maintenance and operation was too great to make it profitable. The new corporation, if it could see economy in moving its freight by canal instead of by rail, would doubtless repair and use the old canal instead of building a railway line to replace it. Its managers believe it to be cheaper to build a new railway line and pay the interest on its cost than to attempt to maintain and operate a canal already built. We commend this fact to the thoughtful consideration of those who are so persistently urging the expenditure of state and national funds on waterway construction and who have not yet found out that the line of rails on solid ground has proved itself a cheaper highway for freight transportation than any shallow water channel, either natural or artificial.

LETTERS TO THE EDITOR.

How is the Expansion Taken Up in a Welded Rail?

Sir: To decide an argument, will you kindly publish in short form the exact movement of the steel rails when they are welded end to end, as was done on the Third Avenue R. R. There is much discussion relative to what becomes of the expansion—if the entire length of rail expands entirely at one end of road, or each length of rail separately. Respectfully yours, "Tired Listener."

(The rail is held by the friction of the paving at the sides, and the result of changes of temperature is to put the metal of the rail under stress, compressive or tensile. Near the end of the line of rails there is some motion, but as soon as we go far enough from the end to make the total frictional resistance, tending to hold the rail from moving, greater than the stress due to the change of temperature, the movement ceases. A full explanation was given in Engineering News of Oct. 27, 1892.—Ed.)

Arbitration in Labor Disputes in New Zealand.

Sir: Noting your remarks regarding the labor troubles in the building trades at Chicago (Eng. News, Nov. 16, 1899), permit me to draw your attention to the legislation by which we have in this colony a Conciliation Board, to whom all these disputes are referred, and by whom they are settled.

There was, some years ago, a serious seamen's strike here, and this legislation was an outgrowth from it. The original act was passed in 1894. The Board is elected by the employers and employees jointly, the State holding authority over it. Much comment was heard at first over the adoption of the principle of compulsory arbitration, chiefly from the employers. The Board has done much work, however, and I believe much trouble has been avoided through its efforts. Yours truly,

Douglas Dobson, Assoc. M. Inst. C. E.

Blenheim, New Zealand, Dec. 23, 1899.

A Diagram for Straight Line Compression Formulas.

Sir: The accompanying drawing shows a method of making and using right line compression formulas. I have never seen a similar one in print, and it is a labor-saving device which will be appreciated by engineers who have occasion to make use of various straight line formulas. The construction is as follows:

Find the location of the line r r by working out the formula with the ratio of l to r, as assumed in the diagram, substituted for the term l ÷ r in the formula. As an example, assume that we will draw the diagram as follows:

Lay out l to a scale of 1 in. = 10 ft. and r natural size. Now in assuming these scales we have divided l by 120, and r by 1, which makes l ÷ r = 120, with l and r expressed in inches, or l ÷ r = 10 with l expressed in feet and r in inches, as in the formula.

Substituting this value in the equation P = 12,500 − 500 (l ÷ r), and reducing, we get P = 7,500, which indicates the location of the line r r on the diagram.

Now draw straight lines from the origin (12,500) through any required value of r, on the line r r, and this diagonal line will give the values of P for any value of l.

The maximum limit of the formula is indicated by the line giving the value of P, which we get by substituting the maximum limit (180 r) in the formula. (Note that 180 becomes 180 ÷ 12 = 15, in order to correct for l being in feet and r in inches.)

The above principle of construction can be applied to any right line formula, and a number of formulas may be shown on the same diagram. This, in connection with a table giving the areas and values of r for the sections usually used, will save much time and work.

Yours truly, O. W. Childs,
Engineer, Stupp Bros. Bridge & Iron Co.

St. Louis, Mo., Dec. 1, 1899.

The Graduation of Transit Circles.

Sir: In "Hints Upon Transit Surveys," published in Engineering News, Jan. 4, 1900, Mr. Gould ignores the transit which has its plate graduated from 0° to 360° in right-handed order, as all good transits ought to be. Earlham College has one transit twenty-five years old,

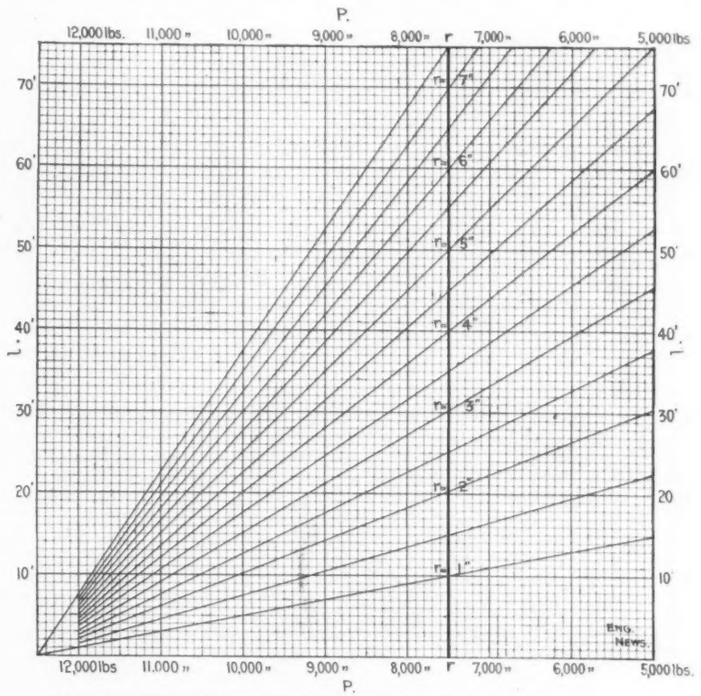


DIAGRAM OF STRAIGHT LINE COMPRESSION FORMULAS.

Formula: P = 12,500 − 500 (l ÷ r).
P = Compression in pounds per square inch.
l = Unsupported length of member in feet.
r = Radius of gyration in inches.

Explanation: Find the required r on the line r — r, then follow the diagonal which crosses at that point, until it crosses the line representing the required l (read at the sides of the diagram). The vertical line through this intersection represents P read at the top and bottom of diagram. Diagonal lines representing r are drawn at each half-inch only. Lines for interme diate values may be drawn in, or a ruler or thread used to indicate them.

so numbered. The idea is neither new nor uncommon, and the advantages are worth mentioning.

With a transit divided from 0° to 360°, the telescope should never be plunged, and one does not have to record "angle right" or "angle left;" the traverse angles themselves do that, and no error of judgment can enter. A valuable field check follows without extra labor.

To obtain the traverse angle of the line from station 2 to station 3, for instance, with the instrument properly set at station 2, make the "A" vernier read the previous reading of the "B" vernier (180°+ traverse angle of line 1—2, theoretically,) when sighting from sta. 1 to sta. 2. Now bring the line of sight on the back flag at sta. 1. With the instrument thus set and properly clamped, loosen the plate and bring the line of sight on sta. 3. The "A" vernier reads the azimuth or traverse angle at once, and giving the proper signs to the sines and cosines of these angles, tells at once whether they are right or left, fore or back traverses. Proceeding thus, when the last station is occupied and the line of sight is brought on the first instrument point, the "A" vernier should read the first traverse angle, and thus we have a valuable check on the entire instrumental work when we most need it, i. e., before leaving the field.

To balance a traverse survey, one may distribute the errors empirically if they are small; otherwise distribute them in proportion to the length of side. Credit for the above should be given to Prof. J. B. Davis, of the University of Michigan. R. L. Sackett.

Earlham College, Richmond, Ind., Jan. 13, 1900.

Another Decision in Favor of the Proposed Dam Across the Rio Grande River at Elephant Butte, N. M.

Sir: In your issue of June 15, 1899, you published a communication from me relating to the effect of a decision of the U. S. Supreme Court in the suit of the United States to enjoin the Rio Grande Dam & Irrigation Co. from building a dam across the Rio Grande at Elephant Butte, N. Mex. (See Eng. News, June 15, 1897—Ed.) The question referred back to the courts of New Mexico by said decision, viz.: "Will the construction of the proposed dam materially impair the navigability of the Rio Grande where now actually navigable?" has just been decided in the lower court in the negative, and, of course, again in favor of the company. The hearing of the court developed the fact that the Rio Grande is navigable for a distance of about 200 miles from the mouth by very small, light draft boats, and is actually navigated for 100 miles by one small boat of 3 ft. draft, which makes one trip once in about four months, and is frequently laid up indefinitely for lack of freight or owing to low water. The court finds that the waters of the river in New Mexico, 800 miles away, do not regularly nor substantially contribute to the navigability of the river near the gulf. This is due principally to the intermittent and erratic flow of the river and to proven losses of great quantities of water by percolation into the very sandy and porous channel along the vast stretches of the river.

The fact of vital interest to the people of the arid west now is that the fight made against storing the waters of the Rio Grande in New Mexico has resulted in the precedent that if irrigation interferes with navigation, the former must give way to the latter being established by the Supreme Court.

This precedent may easily become an effectual obstruction and delay to almost every irrigation project of any magnitude in the West, where irrigation is of paramount importance and navigation a matter of no consequence whatever. Any project of similar kind (and they will all be almost exactly parallel) will have to go through the courts and prove all that the Rio Grande Dam & Irrigation Co. has proven, if there should be any substantial opposition. There is hope, however, that the overwhelming sentiment of the West will frown down the continuation of such a policy.

Our opponents have decided to appeal again to the higher courts. This means more delay. But we have no doubt whatever that the final result will be favorable to irrigation. Yours truly, J. L. Campbell,

Ch. Engr. R. G. D. & I. Co.

Roff, Ind. T., Jan. 13, 1900.

Notes and Queries.

In answer to the query of "W. W. P." in Engineering News of Jan. 11, we are informed that at Reading, Pa., Mr. Hoff, the City Engineer, is also the city's Highway Commissioner, and the results have been excellent.

P. L. S., Utica, N. Y., writes:

Will you kindly let me know what city, or cities, in the State of New York still cling to the old-fashioned title of City Surveyor for the officer at the head of their engineering department.

THE TRANSPORTATION OF A HEAVY BOX GIRDER BY RAIL.

The accompanying illustrations show the method of loading and transporting a heavy box girder recently constructed by the Keystone Bridge Works, of Pittsburg, Pa., for the Manhattan Valley Viaduct extension of Riverside Drive in New York city. The interesting structure, of which this great girder is a part, was fully described in our issue of June 8, 1899, where the composition and manufacture of the girder are shown in detail. As was stated at that time, there are two of these large box girders in the structure, both being in the 130-ft. span carrying the viaduct over Manhattan Ave. Briefly described each of these girders is 129 ft. 3 ins. long, 10 ft. 2¼ ins. deep and 3 ft. wide, and each weighs 124,000 lbs., or 62 tons. Fig. 1 is a view of one of the girders loaded on the cars for transportation, and Fig. 2 shows the principal details of the bracings designed to hold the girder in position during its shipment. This plan of loading was submitted to the railway company for examination, and was approved by the transportation officials.

The two illustrations explain the method of loading so fully that very little description is necessary. Two sets of bracing or bolsters were employed, one being placed at each end of the girder. The bolster and bracing shown by Fig. 2 is the one intended to take up the slip due to passing around curves, and it provides for a total movement of 11 ins. The other bolster was similar in design, but had no longitudinal movement, it being fixed by a 3-in. steel pin, around which, as an axis, it was free to move in a horizontal plain. When loaded the girder extended over four cars, and rested on the two end cars only, the two intermediate cars being employed simply as idlers to preserve the proper spacing and to transmit the pull. The total height from the top of rail to the top of the girder was 13 ft. 8½ ins. The shipment was made by the Pennsylvania R. R., it going by way of the Allegheny Valley Ry., the West Penn Ry., and the main line of the Pennsylvania R. R., to Jersey City, N. J., from which point the cars were taken by one of the company's regular car floats to 68th St., and onto the lines of the New York Central & Hudson River R. R., for delivery at the Manhattan Station of that road.

FIG. 1.—VIEW OF 62-TON BOX GIRDER LOADED FOR SHIPMENT BY RAILWAY.
Keystone Bridge Works, Pittsburg, Pa.

Besides the two box girders described, the Keystone Bridge Works will ship for use in the same structure four plate girders, each 125 ft. 10⅝ ins. long, and 10 ft. 4 ins. high. These plate girders will be shipped in pairs, each pair being loaded in all respects similar to the method adopted for the box girders illustrated. The total weight of each pair of plate girders will be 155,000 lbs., or 77.5 tons. For the information from which this description has been prepared we are indebted to the Keystone Bridge Works, Pittsburg, Pa., Mr. Emil Swensson, M. Am. Soc. C. E., Chief Engineer and Superintendent.

TWO STEAM INTRENCHING MACHINES, invented by Colonel Templer, of the British military balloon service, are on their way to South Africa. The machine is in the form of a great plow, with a very heavy horizontal frame made at an angle of 95°, and provided with two large wheels at the front angle. At the rear angles are two plowshares, 4 × 4 ft. with a 6-in. steel pick in front; these plowshares are made to point either way, so that the one used will throw the earth to the right or left as desired. It is supposed that the steel pick will split or turn aside any rock encountered, when this plow is hauled by a traction engine over the required line. The engine and plow are steel-clad, and it is proposed that they shall precede a line of skirmishers protected by artillery, and make a line of trench to be used in carrying the enemy's position.

THE CAPE HAITIEN & LA GRANDE RIVIERE RY., the only railway in the Island of Hayti, is now well under construction, says U. S. Consul L. W. Livingston, of Cape Haitien. It is being built by a joint-stock company, with the government controlling, and the concession is for 60 years, with a government guarantee of 6% interest on $24,000 per kilometer. The main line is 15 miles long, but the company has the right to build branches of 35 miles, to Ouanaminte, and 19 miles to Limbe. The country traversed is very fertile, especially suitable for banana cultivation, and deposits of coal and iron have been found within easy reach of the line. The company is now seeking capital to complete the branch lines, to cultivate the lands controlled, and to develop the iron and coal mines.

A PNEUMATIC CAISSON GOLD-DIGGER has been tested for some months on the gravels of the Mokelumne River, in California, says the San Francisco "Call." The machine, invented by P. B. Donahou, includes a barge carrying the steam plant and washing apparatus. In the forward part of the barge is a well, and through this by means of guides and hoisting chains, is lowered or raised a cylindrical shaft terminating in an enlarged working chamber. This shaft and chamber is surmounted by an air-lock and is supplied by compressed air in the ordinary way. A pipe passes from a powerful centrifugal pump, through the roof of the working chamber, to the bottom of this chamber, and is fed with gravel by a man stationed in the chamber. The pumped gravel goes to a revolving screen on the barge and the finer material goes through 160 ft. of sluices in which the gold is caught. To aid the man in excavating a force pump supplies him with a powerful stream of water. The plan followed is to sink this caisson through the gravel and thus reach the bed-rock where the best gold is usually found. The device is said to be so successful that four large plants of this type are to be built at once.

A NEW TRAIN, composed of cars specially built for the service, has been put on by the Chicago, Indianapolis & Louisville Ry., to run between Chicago, Indianapolis and Cincinnati. The engine and cars were all built at the shops at Lafayette, Ind. The train consists of a 60-ft. mail and baggage car, smoking car, ladies' and day car, and 68-ft. parlor and dining car. The cars are heated by steam, lighted by the Pintsch gas system, and equipped with the new Adams & Westlake ratchet brake and uncoupling devices. They are all fitted with wide vestibules, and the parlor car has a large observation platform at the rear end. Mr. W. P. Coburn is Master Mechanic, and Mr. C. Coller, Master Car Builder and Assistant Master Mechanic.

ELEVATOR OWNERS ARE COMMON CARRIERS, says the Appellate Division of the New York Supreme Court, in the case of Anna S. Griffen vs. W. D. F. Manice. The husband of the plaintiff, the Secretary of the United States Fire Insurance Co., was killed in an elevator accident at No. 46 Pine St., where he was employed. Certain weights in the cable frame became detached, and falling, killed Mr. Griffen. Though there was a clause in the lease releasing the owner from responsibility for elevator accidents, Justice Patterson held that the responsibility of the owner was similar to that of a common carrier, and he was bound to maintain the machinery in good order. The presumption is that the accident was due to the owners' negligence; and to remove this presumption there must be reasonable evidence of negligence on the part of the person injured. The widow sued for $50,000 damages, and was given $22,500 and $700 costs. This judgment of the trial court is affirmed by the Appellate Court.

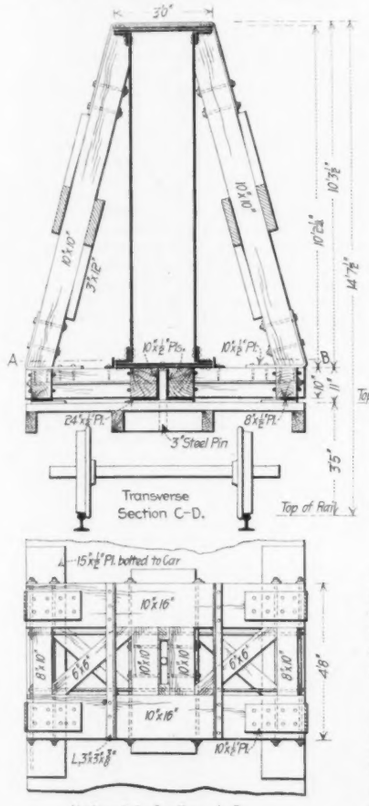
THE PALISADES COMMISSION, appointed by New York to confer with representatives of New Jersey for the acquisition of the Palisades on the Hudson River by the United States, reported to the New York Legislature on Jan. 12. The last Congress declined to consider the bill proposing the establishment of a military park on the Palisades, and the commission now recommends that the state of New York appropriate $250,000, to be paid to the United States government for the purposes intended; and that the government acquire title and develop the land bordering the river for a military park. The intention is to divide the burden of preserving these cliffs between the United States and the states of New York and New Jersey.

SABLE ISLAND, the "Ocean Graveyard," is sinking into the sea, and the Canadian Minister of Marine has detailed the steamer "Minto" to make careful surveys of this island 85 miles off the harbor of Halifax. So far, each new survey of the many made shows this island to be shrinking in size. In 1776, it was 31 miles long and

2 miles wide; in 1816 it was a mile shorter, and at the present time it is supposed to be only 22 miles long and one mile wide.

CONCENTRATION OF THE SUN'S HEAT by means of mirrors has been effected by Dr. Wm. Calver, of Washington, D. C. Flat mirrors, 4 × 6 ins., are used and are arranged to frames on circular tracks so that all the heat is reflected to a central point, and are automatically moved to suit the motion of the sun. An experimental apparatus has been erected containing 810 mirrors, or a total reflecting surface of 135 sq. ft.

THE SPREAD OF THE ENGLISH LANGUAGE is commented upon by the "Journal of Commerce." In 1800 only 22,000,000 people spoke English, as compared with 24,000,000 who spoke French, 38,000,000 who spoke German, and 32,000,000 who spoke Spanish. At the beginning of 1900 127,000,000 people use English as their mother tongue; an increase in the century of 477%, and a greater number than those who speak German and French taken together. In this period the United States has grown from 5,000,000 to 75,000,000 inhabitants; the United Kingdam from 16,000,000 to 41,000,000, and the colonists of England have grown from a few thousand to about 12,000,000. In the same time the population of the European continent has increased from 170,000,000 to about 343,000,000. Thus, while at the beginning of the last century the natives of Continental Europe outnumbered the English-speaking family 8 to 1, they now outnumber the English races only 2.7 to 1.



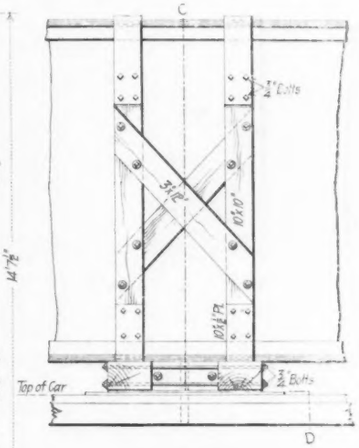


FIG. 2.—DETAILS OF BRACING AND BOLSTER FOR SUPPORTING 62-TON BOX GIRDER DURING TRANSIT.

AN ELECTRIC TRAIN ORDER SIGNAL FOR LOCOMOTIVES.

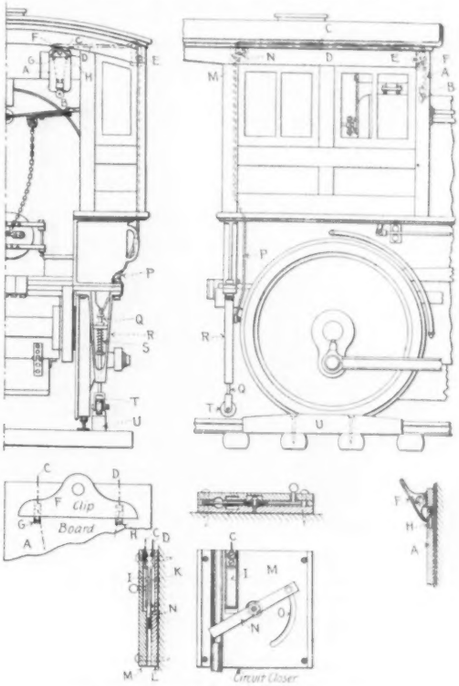
One of the difficulties in ensuring the safety of train service is the occasional overlooking or forgetting of train orders and special orders, and various devices have been introduced to attract the engineman's attention by the use of some visible or audible signal in the cab. In the device illustrated by the accompanying cut, the train order board (A) in the engine cab has attached to it an alarm bell (B), which is placed in a circuit comprising wires (C) and (D) and a battery (E). Connected to the board is a spring clip (F) for holding the train orders, dispatches, etc., and this clip is designed to engage with contact points (G) (H) in the circuits (C) and (D).

Within the cab is a circuit-closer comprising a spring-contact (I) having connection with the wire (C) and a spring-contact (K) having connection with the wire (D), the contacts being secured to a back plate (L) and a front plate (M). A lever (N), pivoted to the inner side of the front plate, moves between the contacts (I) and (K) to close the circuit. Attached to one end of this lever is a knob, the stem of which extends through an arc slot (O) formed in the front plate. The opposite end of the lever extends to a shifting rod (P), the plates being provided with grooves in which the rod moves.

The rod extends down through the cab and is connected with a striker-rod (Q) mounted to move vertically in a hanger (R). The striker-rod is held down by means of a spring (S) surrounding the rod and engaging at its upper end with a cross bar in the hanger, and at its lower end with a collar on the rod. The lower end of the rod is provided with a roller (T) of hard rubber or vulcanite, or of metal with a rubber rim. This roller is designed to engage with a lifting block (U) secured to the ties at the side of the rail and at any suitable distance from a station.

In operation, when the roller rides upon the block the rods will be moved upward and the rod (P) will force the lever into engagement with the contacts (I) and (K), closing the circuit. Should there be no papers underneath the clip (F) or between the clip and the contacts (G) and (H), the alarm will not sound, because the current will be short-circuited by the clip, cutting the bell out. Should the clip, however, be insulated from the contacts by means of paper upon which orders or dispatches are printed, the current will pass through the bell (B), sounding the same to give an alarm, and this alarm will continue to sound until the circuit is opened by the engineman or any person moving the lever. When the roller passes off the track block, the spring will return the rod to its normal position.

This device has been invented and patented (No. 629,624, July 25, 1899), by Mr. W. H. Stillwell, Superintendent of the Chicago, Rock Island & Pacific Ry. (lines west of the Missouri River), of Topeka, Kan. It has only been tried experimentally with one engine, in order to test it at high speeds. Mr. Stillwell states that it worked successfully under these conditions. The cost of equipping an engine would be about $15, but the track blocks would cost practically nothing, being simply wooden blocks spiked to the ties.



ELECTRIC TRAIN ORDER SIGNAL.
W. H. Stillwell, Inventor.

SOME RECENT ELECTRIC FREIGHT LOCOMOTIVES.

By Burcham Harding.*

With the introduction of electric railways into country districts, which has recently been made possible by the use of alternating current electricity with its facilities for long distance transmission, electric freight locomotives are becoming a common feature. An important source of revenue is found in hauling freight cars from steam railroads over the tracks of electric lines. Wherever intersections of steam roads are made, junction lines can be made with the electric roads.

A novel type of electric locomotive has been designed for this purpose by the Baldwin Locomotive Works, and has been electrically equipped by the Westinghouse Electric & Manufacturing Co. The accompanying engraving, Fig. 1, shows a new electric locomotive of this class recently put in operation by the Metropolitan Railway Co. of Toronto, Ont. This company has a line 30 miles in length (shortly to be extended a further 13 miles) running from Toronto to Newmarket, and connecting at North Toronto with the Canadian Pacific R. R. There are several long grades, the steepest of which is 8%. The central power station is situated 18 miles from North Toronto and 12 miles from Newmarket. Two cross-compound condensing engines are belted to two 275 K-W. Westinghouse double-current, 60 cycle, 3-phase generators, running at 600 r. p. m., and wound for 400 volts alternating current, and 570 volts direct current. The direct current is used on the section nearest the station, and the alternating current is raised to 15,000 volts and transmitted to a substation at York Mills, 4½ miles from North Toronto.

The locomotive shown in the engraving has 33-in. driving wheels and weighs 57,000 lbs. It is equipped with four 38-B. 50-HP. Westinghouse motors and Westinghouse air brakes, and is designed to run upon a level at a speed of 20 miles an hour, hauling cars with an aggregate weight of 60 tons. It will be employed for hauling coal cars from the Canadian Pacific Ry. to the power house, and also for distributing Canadian Pacific freight cars in the territory through which the line operates. This is an agricultural district, and has been previously served by the Grand Trunk Ry. only, but the new line gives additional facilities which are readily appreciated by the farming and manufacturing interests. The Metropolitan Ry. Co. also has some motor freight cars, equipped with four 38-B. Westinghouse motors, and other smaller freight cars, with a double 49 Westinghouse equipment. The 49 motor is of 35 HP. The rolling stock also includes a number of single truck freight cars, which are hauled by the double passenger cars, with four motor equipments.

* Pittsburg, Pa.

Freight traffic is becoming a very important feature with electric railroads, as feeders to the steam railroads, and also as a direct means of connection between city and suburban districts. Fig. 2 shows another style of electric freight locomotive, equipped with Westinghouse motors, hauling a car loaded with bags of grain. This view was taken upon the line of the Newburg, N. Y., Electric Ry. Co., which has a very large freight traffic, collecting farm and dairy produce,

FIG. 1.—BALDWIN-WESTINGHOUSE ELECTRIC LOCOMOTIVE FOR THE METROPOLITAN RAILWAY CO., TORONTO, ONT.

and carrying it to the wharf upon the Hudson River, whence it is shipped by boat to New York.

Handling freight cars from steam railroads will soon have a considerable exploitation in Northern Ohio and Southern Michigan. Messrs. Westinghouse, Church, Kerr & Co., of New York, are constructing new electric railways in this region of greater length than have hitherto been built. The Rapid Railway of Detroit will have a length of 73 miles, and a new line from Toledo to Norwalk, a length of 60 miles, each of them operated from a central power house. These lines run through agricultural and horticultural districts, affording a very large freight traffic. It is proposed to employ Baldwin-Westinghouse electric locomtives for this service. The tracks for these lines are of standard gage, built according to the most substantial railway practice, since passenger cars are scheduled to run over them at a speed of 45 miles an hour, and in some cases have exceeded a mile a minute.

REVIEW OF THE PITTSBURG IRON MARKET DURING 1899.

(From the "Official Market Report of the New York Metal Exchange.")

The year 1899 was the best year the iron trade has ever had. The tonnage during the whole year was enormous, prices advanced in all kinds of iron and steel products from 100 to 150%, and it is reported on the very best authority that some concerns made more money in 1899 than is invested in their entire plant. This refers particularly to some of the blast furnaces in the Mahoning and Shenango valleys, all of which made enormous profits last year.

When 1899 opened, it was evident that the year was going to be a good one in all branches of the iron trade, but no one connected with the trade in any capacity foresaw the wonderful activity that prevailed the whole year. Such was the enormous demand for pig iron, billets and finished material, that buyers were often compelled to pay premiums to get material, in fact, it often was not a question of price, but where to get the stuff. All former records for production, profits and everything else were eclipsed in 1899, and in other respects it was also a remarkable year. It was practically free from failures, labor was so busily employed and so well paid that there was no time for labor troubles.

Some very large consolidations were made in the iron trade in 1899, among them being American Steel Hoop Co., which took over seven or eight of the leading hoop and cotton tie mills in the Pittsburg and Valley districts. There was also organized last year the National Tube Co., composed of about fifteen of the leading pipe and tube mills in the United States, the Republic Iron & Steel Co., which is composed of about 35 of the leading iron and steel bar mills in the West and South, and the National Steel Co., which took over six or seven of the leading concerns making Bessemer pig iron, billets, sheet and tin bars, and owns some very modern plants.

Some of the great iron and steel concerns, such as the Carnegie Steel Co., Jones & Laughlins and others, made very large additions to their works last year, which will greatly increase their capacity. The Carnegie Steel Co. bought, early in 1899, three large plate mills from the Bethlehem Steel Co., at South Bethlehem, Pa., dismantled them, and rebuilt them at Homestead, Pa., They also built large open hearth furnaces at the Homestead Steel Works, a new car axle works, and in fact increased the capacity of all their plants in the Pittsburg district. In November last, the Board of Managers of this great concern authorized additions to their works which will cost $5,000,000 or more. They will build two new blast furnaces at Rankin, a bridge across the Monongahela River to take hot metal to the Homestead Steel Works, and a new open hearth plant and blooming mill at the Duquesne Steel Works. Jones & Laughlins are building four new blast furnaces, one of which is completed and in blast, and another will be ready before March 1. Each of these four monster furnaces will have a daily capacity of 600 tons. In the 30 blast furnaces in the Pittsburg district is made over 40% of the entire output of pig iron in the whole country.

Pig Iron.—When 1899 opened there were in blast in the United States 200 blast furnaces with a weekly capacity of close to 250,000 tons, or a total annual capacity of about 12,000,000 tons. As the year progressed and prices of pig iron kept steadily advancing, more furnaces were blown in and the year closed with the output of pig iron in the United States at the rate of about 15,000,000 tons a year. This country easily leads all other countries in the world in the production of pig iron. Remarkable as was the increase in production of pig iron, the advance in prices last year was more so. Bessemer pig advanced from about $10.25 a ton f. o. b. Pittsburg to $25.00 a ton, and some iron is reported to have been sold at even higher figures. The Valley blast furnaces have sold a great deal of pig iron for delivery in first six months of this year at $23.00 to $24.00 a ton at the furnace. Grey forge iron advanced from about $9.00 a ton to $21.00 a ton, and some iron has been sold at even higher prices. Foundry pig iron also advanced $12.00 to $14.00 a ton. In spite of these enormous advances in prices of pig iron the demand has been large all through the year, and took the great output of the furnaces as fast as it was made.

Billets.—The advance in price of Bessemer steel billets in 1899 was unprecedented. When the year opened billets were selling at $15.50 to $16.00 a ton f. o. b. Pittsburg. Before the year closed as high as $41.00 and $42.00 a ton was paid for steel for spot shipment. These prices, however, were exceptional, but thousands of tons of steel were sold at prices ranging from $35 to $39 a ton, an advance of $20 a ton or more over the price at the opening of the year. The price of open hearth billets also advanced even more than Bessemer, and at times during the year they were so scarce they could hardly be had at any price. As high as $45 to $50 a ton was paid for open hearth billets, while they have sold as low as $17 and $18 a ton. All the steel mills ran full last year, and the output was very much the largest in any one year in the history of the trade.

Finished Material.—Prices on all kinds of finished material advanced enormously in 1899, and demand was the heaviest ever known. Sheets and plates went up from 1.10 cts. per lb. to 3 cts. per lb., nearly $40 a ton, and were very scarce all through the summer months. Prices on plates declined a good deal in the last two months of the year. Beams and channels advanced fully $20 a ton, iron bars about $25 a ton, and steel bars fully $30 a ton. No. 27 black sheets have sold as low as 1.75 cts. per lb at mill. In August and September they sold as high as 3.25 cts., an advance of $30 a ton. Galvanized sheet advanced even more. Iron and steel skelp advanced from $25 to $35 a ton, while pipe and tube went up fully 150%. In fact, in the whole line of finished material prices went up from 100 to 150% or more, and the year's business was much the heaviest ever known.

In the last two months of the year demand for some kinds of finished material fell off a good deal, and prices also declined. This refers more particularly to plates, sheets, skelp and iron and steel bars. The outlook for 1900 is excellent, and a heavy volume of business is expected all through the year.

Coke.—As a natural consequence of the iron trade the coke business assumed larger proportions during the past year than ever before. The trade gradually expanded from the beginning of the year, when 16,712 ovens were in blast in the Connellsville region until the closing of the year, when 18,813 ovens were running to their fullest extent, with a great many plants having a number of new ovens in course of construction, and with four more new coke companies organized, at present doing the preliminary work for the erection of about 3,500 more ovens. The total shipments of coke from the Connellsville region were 10,423,000 tons for the year.

The market price of furnace coke at the opening of the year was between $1.75 and $2 net ton. This gradually advanced right through until the end of the year, closing at $3.50 per ton on large contracts running through all

FIG. 2.—BOX CAR FOR PACKAGE FREIGHT HAULING LOADED TRAILER ON NEWBURG ELECTRIC RY.

of the year 1900, and even bringing higher prices for small lots. As a matter of fact there was at the close of the year, and is at the present moment, an actual shortage of coke, with every indication that it will materially advance further.

A particular feature regarding the coke business has been the discovery and development of the new field, which is a continuation to the south of the Connellsville field. At the present time four railways are intersecting this territory with their branch lines. This new field (comprising about 15,000 acres) was entirely taken up, and purchased during the last half of the year, being now owned almost entirely by four of the large steel trusts, each of which has acquired the coal lands and formed a coke company with the idea of producing their own coke in the future.

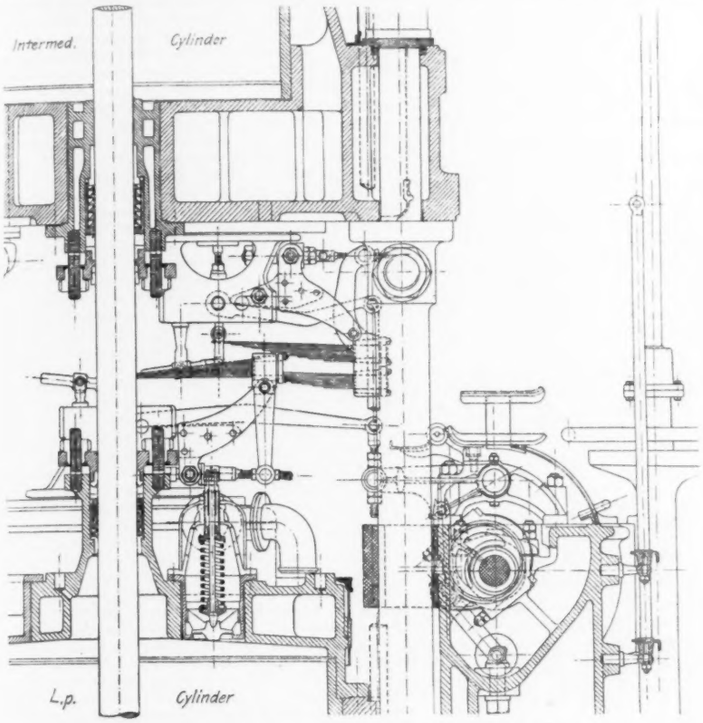


FIG. 3.—SECTION OF INTERMEDIATE AND LOW PRESSURE CYLINDER SHOWING VALVE-GEAR ATTACHMENT.

SULZER TRIPLE-EXPANSION ENGINES FOR THE BERLIN MUNICIPAL ELECTRIC LIGHTING SYSTEM.*

(With full-page plate.)

In the Luisenstrasse power station of the Berlin Municipal Electric Lighting System are two 3,000-HP. triple-expansion engines built by the famous firm of Sulzer Bros., of Winterthur, Switzerland;

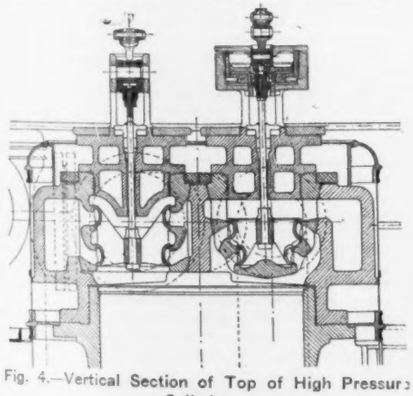


Fig. 4.—Vertical Section of Top of High Pressure Cylinder.

and a third is soon to be added. The engines are of the vertical two-crank type with the cylinders arranged steeple-fashion, there being two low-pressure cylinders, and the principal dimensions are as follows: h.-p. cylinder, 34 ins. diameter; l.-p. cylinder, 49.2 ins.; l.-p. cylinders, 51.2 ins.; stroke, 51.2 ins. The speed is 85 revolutions, giving a piston speed of 725 ft. per minute.

The power developed at different points of cut-off is as follows: 11%, 1,740 HP.; 25%, 2,800 HP.; 50%, 3,860 HP., the percentages being reduced with respect to the high-pressure cylinder. As the engines were built especially for use with superheated steam, the steam-jacket is omitted on the high-pressure cylinder, although all the others are provided with jackets. The bed-plate is formed of two large castings fitted with a turned tongue-and-groove joint and then bolted together, each piece carrying two pillow-blocks. The crank shaft is made of two parts, firmly joined by a flange coupling at the middle. The shaft carries at each end a heavy balance-wheel, and, also directly keyed to the shaft, the armature of a direct-current dynamo. The base plate forms a trough under the shaft and bearings, which serves to catch any oil which may drip from the latter, a channel connecting the two recesses, so that all of the oil may be drawn off at one place. Upon the rear side of the bed-plate are strongly constructed uprights, to which the cross-head guides are bolted, and upon the front side are massive steel columns which support the cylinders. These columns are rigidly connected at about their middle points to each other and to the frame by stays in order to prevent vibration. Furthermore, for the same purpose, the lower ends of the columns are not secured by means of flanges, but pass through eyes in the bed-plate, which are about 60 ins. in length and which they closely fit. The upper ends are secured in a similar manner in lugs cast on the low-pressure cylinders, the bearing being about 39 ins. in length. In this way all forces are well taken care of by ample surfaces in the cylinder castings and in the foundation. Immediately behind the upper attachment of the inclined columns are eyes in which the columns supporting the upper cylinders are secured in a manner similar to that just described. There are three of these, one being in the middle. To prevent vibration of the upper cylinders these columns pass through guides, bolted to the upper end of the low-pressure cylinders. On the front side this cast-iron guide also carries the cam-shaft and other parts of the valve gear. In this way unequal expansion is fully provided for, and sufficient rigidity for the upper cylinders is obtained without diagonal bracing. When in full operation the engine shows no perceptible vibration at the highest speed.

The outboard bearings, which support the armatures of the dynamos, are placed upon planed bed-plates, upon which they are movable, laterally and vertically, by means of levelling screws. The journal-boxes are, moreover, provided with spherical seats. This full provision for adjustment is considered very important, since with double-crank shafts the bearings upon the bed-plate must lie in a fixed common axis, and only the outboard bearings can take care of the bending of the shaft.

The intermediate and low-pressure cylinders are provided with jackets, through which the steam leaving the cylinder circulates. The steam is controlled by four-seated valves with conical seats, and so nearly balanced that the valves are opened with a small force, thus reducing the resistance which must be overcome by the valve gear. The valves are placed in the lower and upper cylinder-heads to reduce the clearance space as much as possible. The advantages coming from this disposition appeared so great that the inconvenience due to having to take down the steam connections at each removal of the cylinder cover was disregarded. However, all these connections are so made that they can be taken apart with little trouble. When the piston rod has been removed the heads of the low-pressure cylinders can be swung out in a horizontal plane between the supporting columns by means of a swinging crane, thus permitting the removal of the piston itself. To replace the steel packing-rings of the low-pressure piston, the cylinder-head may be raised, valves and all, about 20 ins., after loosening a few connections. This is accomplished by placing a prop between the piston and the cylinder-head by means of an opening in the latter and then admitting steam below the piston. For this operation it is not necessary to loosen the piston-rod connections. The removal of the packing-rings is rendered easier from the fact that they are secured in a large ring bolted onto the body of the piston.

In order to secure the most direct steam passage for the steam it was necessary to suspend and their weight is some of the valves, carried by double-leaf spring. This construction, which looks very queer to American eyes, has led to no disadvantage. One of the double springs is alone sufficient, in case of breakage of the other, to carry the weight of the valve and insure its closure. The steam pressure, of course, operates to hold all valves upon their seats, when closed. The use of these hanging valves has greatly improved the whole arrangement of the valve-gear. It should be here noted, however, that in the case of the admission valves to the high-pressure cylinder this hanging arrangement was avoided in order to insure absolutely positive motion in these valves.

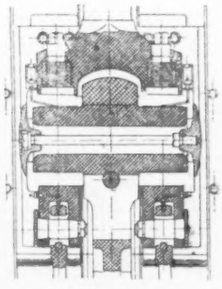


Fig. 5.—Section of Cross-Head.

100-TON SHEAR WITH ADJUSTABLE BOOM.

At the shipyards of Blohm & Voss, at Hamburg, Germany, there has lately been installed a crane of peculiar construction, intended to overcome some of the disadvantages of other similar apparatus. For the description and cut here used we are indebted to "Le Genie Civil," of Dec. 2.

The crane was erected by the Duisburger Maschinenbau, and it is essentially composed of a three-legged shear supported upon a base of two horizontal members, with one leg lying parallel to the wharf and the other making with it an angle of 100°. The sheer-legs are so placed that what may be called the boom describes a horizontal angle of 180°, or 140° over the water. The

*Translated from the "Schweizerische Bauzeitung."

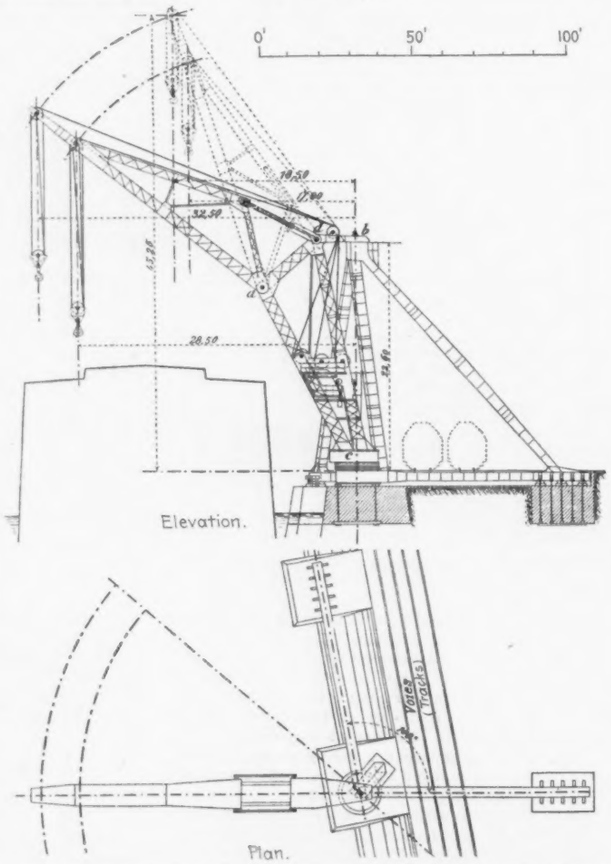
boom itself is hinged as shown, with a vertical movement that gives it a horizontal range of over 50 ft., measured from the axis of the crane.

With the view of obtaining the most economical position for loads of very different weights the crane is provided with two sets of lifting tackle, working upon distinct sheaves. The smaller tackle is intended for loads of 30 tons or less; while the larger one is used for loads between 30 and 100 tons. Each of these two cranes is provided with a combination of gearing that permits the lifting of loads with the following speeds:

	Ft. per min.
Large crane—Loads up to 50 tons	8.5
From 50 to 100 tons	4.3
Small crane—Loads up to 10 tons	39.4
From 10 to 30 tons	13.1

The two cranes are operated by the same engine, which has two cylinders 9½ in. diameter and 16½ in. stroke, and makes 180 revolutions per minute. During the test, loads of 150 tons were lifted by the large crane and 40 tons by the smaller one; and with these loads all movements were made without difficulty. As indicated in the sketch herewith reproduced, the sheer or boom is made of six latticed members, in two distinct parts, but articulated at one point and connected at the other by means of two endless screws made of Martin-Siemens steel. By the rotation of suitable gear, the apex of the upper part of the boom may be pulled towards the axis of the crane until it assumes the position shown by the dotted lines. This movement is made by a separate engine.

Upon the large crane the load is carried by 8 parts of wire cable on two sets of sheaves, each part having an ultimate strength of 100 tons; in the smaller crane the load is carried by four cables on one set of sheaves; all of these sheaves have ball-bearings. In horizontal movement, the whole crane and its load revolves at the bottom on a circular sliding support; which gives satisfaction owing to the materials used and the care with which it was made and is lubricated. The frictional resistance is even less than had been calculated. Rolling supports were decided against on account of the weights to be imposed and the small space available. The lower or fixed part of the support is toothed and in these teeth operate two small pinions with their axes fixed to the moving part and under the control of the motor-engine. Steam is led to this engine from the workshops of the company and through a pipe passing up the axis of the crane. One man operates the crane from a platfrom placed about 16 ft. above the ground.



PLAN AND ELEVATION OF 100-TON SHEAR AT THE SHIPYARDS OF BLOHM & VOSS, HAMBURG, GERMANY.

RECENT PROGRESS IN THE ELECTRICAL INDUSTRIES.*

The progress made in steam and electrical appliances has been all that could be reasonably expected, though not all that might be desired. The most substantial progress in all lines has been towards the improvement of former developments by the lessons of experience and better mechanical work. The steam turbine has been Americanized and bids fair to supersede, in a great measure, our present engines. Experimental work has indicated a marked economy of steam consumption with other desirable advantages. American high-speed engines, capable of being directly coupled to arc dynamos, are in successful operation, and steam economy equals most modern multi-expansion engines. The older types of engines have nearly all been greatly improved in detail; and there is a constant tendency towards smoother running and better regulation. The exploitation of the electrical business has done much toward the development of steam practice.

The constant-current transformer is here to stay, and street illumination by series alternating inclosed arc lamps seems to be a decided improvement over the old series continuous current open arc. The distribution of light is very materially improved, and the serious objection to the old open arc of lack of uniform illumination has been partially obviated.

Gas engines are now being built with satisfactory regulation and of any desired size. Two central stations, to the writer's knowledge, have adopted them as prime movers, and have selected sizes as high as 650 brake HP.

Aluminum wire is already in satisfactory use as a substitute for copper conductors; and, in view of the inflated price of copper, it would seem advisable to use aluminum as much as possible, to assist in bringing the price of copper to a more reasonable figure.

The use of exhaust steam for heating neighboring buildings, either by its direct transmission or by the circulation of hot water, is being adopted by numerous plants.

The distance and high voltage limit of transmission is being constantly increased; and one of the recent plants exploited will transmit current for an extreme distance of 155 miles at 60,000 volts. Two installations will be made during the coming year, of 25,000 volt cables underground.

The manufacture of producer gas is capable of further development and economy; and even under present conditions, producer gas and gas engines will yield a unit of energy for the least consumption of fuel. This field deserves the serious attention of engineers. It has a special value to central stations and other power plants with an irregular load. The best steam engines are only economical between certain ranges of loads, and are generally very uneconomical on light loads. The average boiler and furnace of an electric light plant work at a high efficiency only during a fractional portion of a day.

The necessity of a better distribution of street lighting is fast becoming apparent and the incandescent lamp may yet prove a formidable arrival in this field. I know of no city where it has been given a fair trial.

The central station business is capable of greater development than is generally appreciated. Some cities have installed more than one incandescent lamp for each inhabitant, while others have less than one-fifth of a lamp per inhabitant. Our expenses are made up largely of fixed charges, which are not greatly influenced by the volume of business done, and the larger the volume, the lower will be our K-W. cost at the lamp, and the larger will be our net profits. Some business is not desirable, but with our present system of rates, we are unable to distinguish between desirable and undesirable business. The direct current stations, by virtue of the limitations of the system, have been compelled to confine their efforts to the more profitable class of business, while the alternating current stations have often lost enough money on a certain proportion of their patronage to make the entire investment a loss instead of a profit.

There has been little improvement in the direct current methods in the past few years; but the most marked improvement has been made in the alternating current appliances and methods. "Unaccounted for current" in alternating current stations has often amounted to 80% of the output, and 60% is more nearly the average than the extreme. Modern transformers, up-to-date methods and equitable rates should reduce the "unaccounted for current" to an almost negligible amount.

The average central station is handicapped for the following reasons: (1) Improper and insufficient education of operators; (2) poor accounting; (3) lack of capital; (4) inequitable rates. The ultimatum of perfection in central station operation requires education in all branches of engineering, accounting and business methods. Good judgment and diplomacy are such necessary attributes that their mention here would be superfluous.

I would recommend further education of present employees. Many correspondence schools are springing up and I know some of them are good. The promoters of this method of education are doing a great philanthropic work. They may be unconscious of it, and are, undoubtedly, prompted by personal gain; but, nevertheless, correspondence schools bid fair to do much towards our progress and have many advantages peculiar to themselves. They reach the man who wants an education, and the man who knows what kind of an education he wants. They reach the man who is probably engaged in the very work he is studying, and his education and practical experience go on simultaneously, and his work is apt to keep him interested in his studies. They place within the reach of all the means to take advantage of the opportunities that are apparent to them.

If the accounting for central stations was intelligently and carefully done, and each item of their total expenses could be determined and comparred with previous periods or results in other plants, I am inclined to think that the benefit would amount to more in the profit and loss account than the knowledge of how to construct dynamos with an efficiency of 100%. Perfect superintendence is only to be had when supplemented by intelligent accounting and record keeping, and the use of registering and recording instruments. Good scales, engine indicators, recording station wattmeters and consumers' house meters will enable daily determination of "boiler efficiency" and "combined engine and dynamo efficiency" and monthly determinations of "line, transformer and meter efficiencies." In many instances I would go even further than this, and recommend primary meters on every bank of transformers, and thus check the accuracy of consumers' meters by districts, and enjoy a better opportunity to protect the station from thefts of current.

Each separate item of cost should be accounted for separately, and items like fuel, labor, repairs, etc., should be determined per K-W. for monthly or other convenient periods, and compared with other similar periods, aiming, of course, to continually reduce such cost. Cost of reading meters and trimming arc lamps should be computed both on the cost per K-W. sold, and also on basis of cost per meter and arc lamp installed.

The necessity for some equitable method of charges is of greater importance than the attention given this matter would lead one to believe. Flat rates for a steam plant are almost absurd, yet have some peculiarly redeeming features. Sraight meter rates are so inequitable as to render one customer highly profitable and another customer absolutely unprofitable, both paying a uniform rate. Sliding scale meter rates are generally based on nothing and merely represent the whim of the maker. The Wright-Demand meter and the General Electric Co.'s two-rate meter are steps in the right direction, but cannot be regarded as anything more than makeshifts. The plan of charging a certain rate for the complete installation for the first hour, and a lesser rate for each succeeding hour is often more equitable than either, and is far more simple. All plans so far proposed are manifestly inequitable under some conditions.

The agitation about "municipal ownership" seems to be as active as ever; and, to be frank, I think it is increasing rather than diminishing. Without commenting on the motives of many of the leaders, it must be admitted that others of them are sincere and honest in their advocacy of this cause. If this craze is allowed to run its course popular opinion will, in time, desert it; but in the meantime, many of our properties will be injured, and the

* Abstract of presidential address delivered at the annual convention of the Northwestern Electrical Association, at Milwaukee, Wis., Jan. 17, by Mr. Henry L. Doherty.

cities adopting it will reap a harvest of disappointment for their failure to give the matter proper consideration.

"You can't fool all the people all the time," and more than one community has awakened to the fact that municipal ownership did not yield what was promised. I challenge anyone to cite a single instance where a municipal plant cost no more than was anticipated and yielded all that was promised.

I attended the Convention of the League of American Municipalities by invitation from them, as the representative of the Northwestern Electrical Association and the National Electric Light Association. Other representatives and myself contended that municipal ownership had not been a success in the past, and we could not see how they could expect to make it a success in the future. We offered, on behalf of the National Electric Light Association, to bear half the cost of an investigation of twenty municipal electric plants, selected by the president of the League, to determine the true cost of service for comparison with the rates charged by private plants.

We made this offer in good faith, believing that an investigation would vindicate our position. I regret to state that the League failed to accept our proposition in a manner insuring its execution. Their acceptance on any terms was only secured by a great effort, and their final acceptance was promised conditional upon their ability to provide funds, and, as far as I know, they are making no effort to raise them. I would recommend, if they cannot otherwise be induced to make this effort, that our association solicit subscriptions and notify them that if they will make an earnest effort to solicit funds amongst the advocates of municipal ownership, we will guarantee them enough more to make the necessary amount of $2,500.

Did any of the people who continually harp on the free use of city streets ever stop to calculate how much we save the streets in wear and tear, and resultant noise and confusion, were the energy we deliver in the form of electrical current and gas to be transported over the streets in the form of solid material? Do they ever stop to think that street railway travel is more convenient and less than one-fifth as costly as the best known other means? Any other system of transportation would cause greater use and wear of streets to obtain the same service, which never could be so good.

Generally, all we ask is to be let alone; we should, however, enjoy better protection from thefts of current, and a permanent method of taxation should be decided upon. As a matter of justice, and for the sake of developing our natural resources, the companies developing water powers and transmitting at long distance, should be granted the right of eminent domain. Interference with high voltage transmission lines should be so severely punishable as to offer the most complete protection to these properties.

The development of water powers represents a field of great activity, and one highly profitable is backed by caution, good engineering and judgment. Hasty conclusions, bad engineering and improper decisions have and will bring disappointment. A water power is good for its minimum capacity only; and volumetric calculations on the flow of the stream cannot be too carefully made or gagings taken for too long a period. Each development has its own particular difficulties, such as anchor ice, freshets back water and suitable foundations, requiring not only intelligent engineering, but experienced engineering.

The power thus secured is not always quickly salable, and unexpected extra costs have often run the fixed charges to a figure that, when added to the operating expenses, exceeded the cost of steam power. This has been the case particularly when the cost has been reduced on the basis of quantity sold. Many central stations have a maximum load peak 15 to 20 times the minimum load; and, if the cost of development per unit of power is high, the anticipated profits are never realized.

A NEW EXTENSOMETER.

By Wm. H. Kenerson,* M. E.

The instrument here illustrated was designed to meet the requirement of an extensometer, which, while possessing the advantage of tracing an accurate stress-strain diagram, would at the same time furnish micrometer readings which could be used either as a check on the diagram or for independently calculating the modulus of elasticity.

The upper and lower clamps, which are cut so as to be readily removed from the specimen, are fastened to the specimen by three and two-clamp screws, respectively. The lower clamp is prevented from rocking by two angle pieces held in place by thumb screws. One screw in each clamp passes through a nut which is urged toward the specimen by a stiff spiral spring, thus causing the clamps to remain firmly attached when the specimen is reduced in diameter by stretching. The nuts for the micrometer screws are suspended on either side at points equally distant from the specimen by universal joints and the lower ends of the micrometer screws rest in spherical sockets at points also equally distant from and on either side of the specimen. By this arrangement, if, as usually occurs when the specimen is held by the ordinary wedge grips, it at times stretches faster on one side than on the other, or if the clamps are not at right angles to the specimen, the figure formed by joining the points of support of the micrometer screws is a trapezoid of which the axis of the specimen is the median line. The screws have forty threads to the inch and the graduated disks, which are 3 ins. in diameter, are divided into 250 parts, thus reading easily to ten thousandths of an inch. The pointers for reading are attached to the dust caps on the nuts of the micrometer screws. On the hubs of the graduated disks are cut helical grooves having the same pitch as the micrometer screws. In this groove is laid a light, firm cord, which passes from one hub to the other, over the guide pulleys and around the pulley attached to the cross-head. The cord is laid in the helical grooves so that as the screws travel downward the cord will be unwound from the hubs upward at the same rate, thus maintaining the same horizontal position of the cord. As the cross-head is weighted it causes the screws to follow up the stretch of the specimen and holds them in their sockets with a constant pressure. Behind the rods which guide the cross-head is suspended a drum

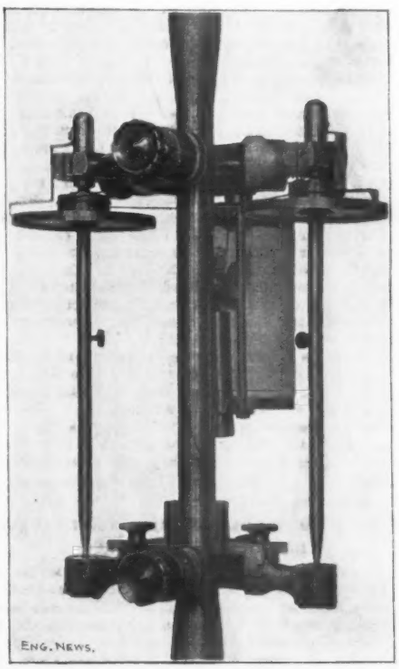


Fig. 1.—Autographic Extensometer Used in the Testing Laboratory of Brown University, Providence, R. I.

Designed by Wm. H. Kenerson, M. E.

with its axis parallel to the rods. The drum is provided with clips for holding the paper on which the diagram is traced. The pencil for tracing the curve is attached to the cross-head. The cross-head, as the specimen stretches, will descend a distance equal to one-half of the sum of the lengths of the cord unwound from the two hubs, that is in exact proportion to the stretch of the specimen. This proportion can, of course, be regulated by the diameter of the hubs. The drum is actuated by the poise through a suitable reducing mechanism. The drum can be easily removed from the upper clamp whenever it is desirable to supply fresh cards. In order to prevent injury to the micrometer screws in case the load should be removed before raising them, the sockets in which the lower ends of the screws rest are held in place by springs which would be depressed by any unusual pressure.

The micrometer screws have extension pieces for specimens of different lengths, which pieces are capable of slight adjustment. This serves to take up the set when several cards are taken successively from the same specimen. A socket is provided in the upper clamp opposite one of the clamp screws in which a knife-edged stud may be placed for clamping to flat specimens or those which could not be conveniently held by three screws. To facilitate attaching the clamps to the specimen a bed has been constructed provided with parallels for supporting the clamps and with centers for holding the specimen. The parallels are marked for different gaged lengths; and when the clamps and the specimen are placed in position, the screws are set up and the whole is ready to be placed in the machine.

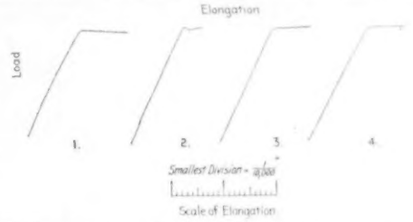


Fig. 2.—Specimen Cards Drawn by Kenerson Extensometer from Steel of About 38,000 lbs. Elastic Limit, and with a Modulus of Elasticity of About 30,000,000.

(Reduced to one-fourth original size.)

The writer wishes to express his indebtedness to Prof. E. C. Burnham for valuable suggestions and advice in regard to the design and construction of the instrument.

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BOOK REVIEWS.

ELECTRIC POWER TRANSMISSION.—A Practical Treatise for Practical Men. By Louis Bell, Ph. D., Mem. Am. Inst. E. E. Second edition, revised and enlarged. New York: Electrical World and Engineer. Cloth; 6 × 10 ins.; pp. 505; 230 illustrations. $2.50.

Dr. Bell's excellent work has been for some time the best book on this subject. Its value is appreciably increased in the present edition by the addition of a short chapter on recent achievements in high-voltage transmission. In the remainder of the book certain minor errors in the former edition have been corrected.

ANALYSE CHIMIQUE QUALITATIVE.—Par M.—E. Pozzi—Escot, Chimiste, Redacteur au "Praticien Industriel," Membre de la Societe Francaise de Physique. Paris: Gauthier-Villars, 55 Quais des Grands-Augustins. Paper, 7½ × 4½ ins.; pp. 180; illustrated; paper, 2.50 francs; boards 3.00 francs.

In this work the author sets forth the methods of determining the different elements entering into the composition of minerals, water, gases, etc., especially as these methods are applied in the industrial arts. They include the various dry methods of analysis; by reaction; and the wet methods. The principal characteristics of bases and of acids are given, and the concluding chapter deals very fully with the analysis of water.

ENGINEERING STUDIES.—Part I. American Stone Arches. By Charles Evan Fowler, M. Am. Soc. C. E. Engineering News Pub. Co., 220 Broadway, New York. Paper; 7 × 10½ ins.; pp. 15; illustrated. 25 cts.

This is the first of a series of studies of bridges selected particularly for their æsthetic merits. In these studies the general appearance of each structure will be shown by a half-tone engraving from a photograph, and there will be appended to each engraving a brief critical description pointing out the good and bad features in the design. The first part, now issued, illustrates and describes eight of the best known stone arch bridges of the United States, including the Cabin John Arch and the famous High Bridge at New York city. Succeeding parts or sections will treat in a similar manner other American stone arches, foreign stone arches, bridge approaches of masonry, bridge towers and portals, notable bridge piers, tunnel portals and other engineering works of a like character. Examples of both foreign and American work will be illustrated in each case. The illustrations and text are printed on a smooth-finish, heavy paper, so as to bring out the best qualities of the half-tone engravings.

HYDRAULIC DIAGRAMS FOR THE DISCHARGE OF CONDUITS AND CANALS.—Based upon the Formula of Ganguillet and Kutter. By Charles H. Swan, M. Am. Soc. C. E., and Theodore Horton, Jun. Am. Soc. C. E., with a Description of the Diagrams and Their Use by Theodore Horton. New York: The Engineering News Pub. Co. Cloth; 6 × 9 ins.; pp. 43; 16 diagrams or plates. $1.

These diagrams are briefly described in the preface, as follows:

The following set of diagrams, based upon the formula of Ganguillet and Kutter, is intended for use in the study of such sections of conduits and canals as are commonly

employed in sewerage, water supply, water power and land drainage.

The set includes conduits of eight different types of cross-section, and canals of rectangular and trapezoidal cross-section.

In presenting this set of diagrams, it has been the aim of the authors to cover the field with as limited a number of diagrams as will readily conform to a simple and practical system for use. A short discussion of the formula and a description of the diagrams and their use appear on the following pages.

As this is one of our own publications, we will only add that the late Mr. Swan was, for some years before his death, and that Mr. Horton, for several years past, has been and still remains connected with the engineering department of the Metropolitan Sewerage System, and in that capacity made a large number of the hydraulic calculations necessary for that extensive work.

AN OUTLINE OF VENTILATION AND WARMING.—By William J. Baldwin, M. Am. Soc. C. E., Expert in Heating and Ventilation. Published by the author, 106 Beekman St., New York. Cloth; 12mo.; pp. 70. $1.

The author of this little book is well known as the author of two large works—"Baldwin on Heating," now in its fourteenth edition, and "Hot Water Heating and Fitting," which are standard works of reference. His present book is a brief essay on the first principles of heating and ventilation. It may serve as a "first book" for students of the subject, but it also contains some matter which will be appreciated by architects and engineers. A diagram which has been constructed by the author from Pettenkofer's experiments, showing the quantity of fresh air necessary for ventilation for individuals of various weights from 30 to 170 lbs. under various conditions, such as repose, gentle exercise or study, in hospitals, and at very hard work, together with the quantity required in schools by the Massachusetts law, is especially useful. We would suggest that a few slight changes be made in the next edition. The definition of the "Mechanical Engineer's Horse Power," on p. 23, should be omitted, as it is not based on any standard authority. The definition used by mechanical engineers in this country and endorsed by the Committee on Boiler Tests of the American Society of Mechanical Engineers, is 34½ lbs. evaporation from and at 212°, which is equivalent to the "Centennial Horse Power" as defined on p. 22. On p. 45 the word "data" is used in the singular number. This is a very common error of proof-reading in engineering publications, but we know of no dictionary authority for it. The word is the plural of "datum."

TESTS OF THE ROEBLING SYSTEM OF FIREPROOF CONSTRUCTION.—Illustrated with Drawings, Photographs and Sketches. New York: The Roebling Construction Co., 121 Liberty St. Paper; 6 × 9 ins.; pp. 175; illustrated. $2.

Although this book is issued by a private firm for business purposes, the value of its contents is such that we list it here instead of in the department of "Trade Publications."

As many of our readers will recall, in 1896-7 an elaborate series of tests was carried out by the New York Building Department to determine the resistance of various forms of fireproof floors to attack by fire and by water. At the time these tests were made they were reported in this and other technical journals as fully as space permitted. It was the intention of the Superintendent of the Building Department, however, that the official records of all these tests should be published in full after the series was concluded. The change of administration and of the control of the Building Department, however, prevented the carrying out of this plan, and hence these records have been inaccessible to the profession.

The book before us is a reprint of these official records, covering the various tests made of the Roebling floors, including a comparative test of Roebling and hollow tile arch floors. The records include the official statements of the engineers conducting the tests and the inspectors of the Building Department who witnessed them, and reproductions of photographs and sketches made by the Department officials. The last 50 pages of the book contains miscellaneous material of interest, including records of drop tests at the Hotel Savoy, Boston; researches upon the effect of high and low temperatures on cinder concretes and on the effect of cinder concrete on steel imbedded in it, and in conclusion a paper discussing the general subject of fireproof construction by Mr. A. L. A. Himmelwright, M. Am. Soc. C. E.

The typography and illustrations of the book are admirable, and despite the fact that it is issued by a manufacturing concern primarily for the purpose of commending its product to users, it is an important addition to the literature of fireproof construction.

BETWEEN THE OCEAN AND THE LAKES.—The Story of the Erie Railroad. By Edward Harold Mott. New York: John S. Collins. Cloth; 4to.; pp. 511; illustrated. $7.50.

This book is a history of one of the most important and interesting of American railways, and the project for the Erie R. R. was, in fact, the first project for a great trunk railway. The book commences with the early project of Gen. Clinton for a government highway from the Hudson River to Lake Erie, which project was also advocated by Gov. DeWitt Clinton, who later abandoned it for the Erie Canal project, and ridiculed the assertions of Col. John Stevens that he could build a steam railway which could transport goods more effectively and cheaply than the canal. The railway project was first brought to the attention of the public by a pamphlet issued in 1829 by William C. Redfield. The charter was granted in 1832. The report of Benjamin Wright, Chief Engineer of the New York & Erie R. R., on the first survey is given in full, but it is stated that the maps, profiles, plans of structures, etc., are not to be found. The various stages of progress in carrying out the scheme, and the numerous troubles and difficulties encountered, are presented in considerable detail. In 1836 the State passed an act loaning the railway $3,000,000, but in 1841 the company announced its insolvency. Mr. Horatio Allen became one of the directors in 1843, and in 1851 the line was opened from Piermont to Dunkirk. Separate chapters deal with the history of the company under its various presidents, down to the administration of Mr. E. B. Thomas, 1895 to 1899. Naturally, there is considerable space devoted to the Erie R. R. scandals. This part of the history occupies the first 300 pages of the book.

The chapter on the construction of the road is of special interest, and we find that the first proposition was for a timber structure carrying the rails 2 ft. 8 ins. above the ground, so as to be clear of snow, and in 1832 stone blocks or wooden posts were proposed to carry cast-iron chairs for the rails. The first advertisement for proposals for construction was issued in 1835, and in 1839 proposals were invited for rails, ties, sills and piles, and the contract prices are given. The rails were to be 3½ ins. high and 4 ins. wide at the base, weighing 56 lbs. per yd., and the specifications are given in full. The story of the roadway on piles, and the details of construction, are also given, as well as particulars of the way in which the company paid its contractors' claims, and we have an interesting account of the war between two rival sections of the Irish laborers empolyed on the works, followed by attacks on the German laborers. We regret to find, however, that in the description of the Starucca viaduct the late Col. Julius W. Adams, M. Am. Soc. C. E., the eminent engineer, is referred to merely as "Julien W. Adams, a leading contractor and bridge builder on the Erie." This chapter includes not only the Erie R. R. proper, but also the New York, Pensylvania & Ohia R. R. and the various branches. Another chapter deals with the early locomotives, cars, and train service. It also describes some of the early accidents, including the failure of one of the three iron bridges in 1850, which led to the substitution of timber structures. One chapter is devoted to the legislative investigation of the Erie R. R. affairs, and another to biographies of the several presidents, and there are also lists of the various boards of directors and operating officers. The book closes with a descriptive list of cities and villages on the line.

The book is handsomely printed, and is illustrated by reproductions of some old drawings and time tables, etc., and by a number of portraits, including "Jim" Fisk (in uniform) and Mr. Augustus S. Whitton, who was a member of the engineer corps in 1838. There is a list of contents, and a list of illustrations, but there is no index, which is a regrettable defect in a book of this size and character.

ANNUAL CONVENTION OF THE NORTHWESTERN ELECTRICAL ASSOCIATION.

The eighth annual convention was held at Milwaukee, Wis., Jan. 17, 18 and 19, the headquarters and place of meeting being in the Pfister Hotel. The Chicago members and guests went up on a special car over the Chicago & Northwestern Ry.

At the morning session on Jan. 17 there was a small attendance, and the time was occupied largely by a discussion of proposed amendments to the constitution and by-laws, and by other similar routine business. The president, Mr. Henry I. Doherty, also read the annual address, in which he discussed at some length various matters respecting the development of the electrical industries, and particularly in regard to central station affairs. An abstract of this is given in another column. The address spoke strongly in opposition to municipal electrical plants, and this view was received with applause, the association being composed of representatives of electric lighting companies. In a brief discussion which followed reference was made to the unsatisfactory condition of the municipal plant at Austin, Tex., where the taxes are very high, in order to pay the interest on the bonds, and where the water-power dam is found to be defective and leaky to a serious extent.

At the afternoon meeting there was a much larger attendance. The secretary, Mr. Mercein, read his address, and the question of holding a summer meeting was taken up, and, after some discussion, was referred to a committee. The report of the Protective Committee was then presented by Mr. Norcross, recounting the steps taken in regard to adverse legislation in the Wisconsin legislature. Last year it was proposed by the legislature to increase the tax laid upon the electric lighting and power companies, without any inquiry as to whether the financial conditions of the companies would warrant it, the assumption being that such companies make too much money out of the people and should be mulcted as far as possible. Through the initiative of this association and its Protective Committee, representatives of the companies were heard, and a legislative Committee on Taxation was appointed to consider the matter. The report recommended that the taxing should be fixed by the local boards of assessors and should not be fixed uniformly under a state law. As a result of the discussion on this report, a Committee on Taxation was appointed, with representatives from Wisconsin, Iowa, Indiana, Michigan and Minnesota.

Designs for a new and more satisfactory badge were submitted, and new members were then elected.

The first paper on the program was then presented: "Modern Developments in Alternating Current Series Arc Lamps," by Mr. R. Fleming, of Lynn, Mass. In the discussion Mr. Allen, of Baraboo, Wis., said he had found the system very satisfactory on the whole. There is no trouble with the lamps, which give the full life of the carbon and make less noise than the open lamps, while the regulation is very close. The alternating current lamps give a better effect, owing to the better diffusion of the light, although the direct current lamps give a stronger light within a limited radius. Mr. Murdock said he had used the series alternating system for incandescent lamps, with about 300 lamps to a circuit, the system being specially adapted to residence districts. The lamps are reduced from 34 c. p. to 25 c. p., and some of them give a light of 10,000 hours.

A paper on "Alternating Current Phenomena" was then read by Prof. Jackson, of the University of Wisconsin. In this he showed the analogy between direct and alternating currents and the continuous flow of water in pipes, the intermittent flow of arterial blood and the intermittent flow and ebb of tides. He also compared these currents to the flow of water in pipes as delivered by a centrifugal pump (with continuous flow), a reciprocating pump (with intermittent flow), and a reciprocating pump having the check valve removed, so that the water column would follow the piston in both directions. The phenomena of the current were also discussed graphically and mathematically, and in the discussion it was pointed out by several members that this would be a very excellent paper to put into the hands of intelligent employees. The representative of the International Correspondence Schools offered to print several thousand copies of this paper, without expense to the association, the papers to be distributed among this class of men. The offer was accepted, with the thanks of the association.

At the morning meeting on Thursday, Jan. 18, the first paper presented was one on "The Combination of Electric Lighting and Hot Water Heating Plants," by Mr. W. H. Schott, of Chicago. This brought out considerable discussion as to methods of piping and the utilization of exhaust steam, and Mr. A. J. Stahl described the Yaryan system of heating and lighting from a central station, as applied at Toledo, O.; La Porte, Ind., and other places.

A paper on "Central Station Economies," was then read by Mr. H. W. Frund, of Vincennes, Ind., the paper relating to meters, meter records, accounts, and the proper analysis of the meter and financial records. Mr. Doherty said he thought good book-keeping would in many cases result in more economy than the introduction of a new plant. In cases he had investigated the fuel charges ranged all the way from 0.48 to 3.30 cts. per K-W. hour. Mr. Bean, of St. Joseph, Mich., referred to the great importance of getting the greatest economy out of an old plant until the company can afford to keep up with the times by putting in the latest improvements in machinery and apparatus. A paper on "The Induction Motor" was then read by Mr. Ralph D. Mershon, of New York, N. Y., describing the elemental principles and the special features of this class of motors.

At the afternoon meeting officers were elected, as follows: President, Pliny Norcross, of Janesville, Wis.; First Vice-President, H. W. Frund, of Vincennes, Ind.; Second Vice-President, H. J. Gillis, of St. Paul, Minn.; Secretary and Treasurer, T. R. Mercein, of Milwaukee, Wis. Mr. Norcross was called to the chair, and made a few remarks in acknowledgment of his election.

The question of holding a summer meeting was then taken up, and after the usual desultory discussion common to such questions, it was decided that a meeting should be held, and that it should be at Waupaca, Wis., but the date was eventually left to a committee.

A short discussion followed on the paper on "The Induction Motor." A committee was appointed to consider the advantages of correspondence schools to the employees of central stations. The amended by-laws, as submitted by the special committee, were adopted, and the committee on badges was authorized to act in conjunction with the president and secretary to select a suitable design.

After these proceedings two other papers were presented: "Relative Desirability of Various Types of Engines on Central Station Loads," by Prof. Richter, University of Wisconsin; and "A Life Test of Incandescent Lamps," by Prof. Shepardson, of the University of Minnesota. The hour was so late, and the attendance had thinned out to such an extent, that there was little discussion on either paper.

In the evening the annual banquet was held in the hotel. Several supply firms had exhibits of lamps and appliances in the private parlors of the hotel, and mention of these is made in our supplement.